HERBAGE PUBLICATION SERIES

BULLETIN No. 15

Grassland and Forage Crops in Thuringia, Czechoslovakia and Hungary

---

ABERYSTWYTH, AUGUST, 1934

HERBAGE PUBLICATION SERIES

BULLETIN No. 15.

GRASSLAND AND FORAGE CROPS IN THURINGIA, CZECHOSLOVAKIA AND HUNGARY.

633.2/3 (4–191)

By

R. O. WHYTE

in collaboration with Prof. E. KLAPP, Prof. F. CHMELAŘ, Ing. RUDOLF FLEISCHMANN and Dr. G. LENGYEL.

[BIBLIOGRAPHER — G. M. ROSEVEARE.]

PUBLISHED BY THE
IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS
AGRICULTURAL BUILDINGS
ABERYSTWYTH
WALES, GREAT BRITAIN

Price 3/6

August, 1934

CONTENTS.

	Page.
Introduction.	5
Summary.	6
Grassland and forage crops in Thuringia. .. .. [Article prepared by R. O. Whyte, E. Klapp and G. M. Roseveare.]	9—29
Grassland and forage crops in Czechoslovakia. .. .. [Article prepared by R. O. Whyte, in collaboration with Fr. Chmelař.]	30—44
Grassland and forage crops in Hungary. .. .. [Article prepared by R. O. Whyte, in collaboration with R. Fleischmann and G. Lengyel.]	45—57

ADDRESSES OF EUROPEAN COLLABORATORS.

Professor E. Klapp (up to April, 1934): Anstalt f. Pflanzenbau u. Pflanzenzucht, Jena, Hindenburgstrasse 3. Germany.
(after April, 1934): Institut f. Pflanzenbau u. Pflanzenzüchtung d. Landw. Hochschule, Hohenheim, Württemberg, Germany.

Professor Fr. Chmelař, Seed Testing Station of the Institute of Agricultural Research, Kvetná, 19, Brno, Czechoslovakia.

Saatzuchtdirektor Rudolf Fleischmann, Pflanzenzuchtstation, Kompolt, Hungary.

Dr. G. Lengyel, Royal Hungarian Seed Testing Station, Budapest II., Kisrókus-u. 15. Hungary.

TITLES OF MAPS.

Map No.		*Page.*
1.	Area of Europe under review.	7
2.	Thuringia. Elevation.	9
3.	Thuringia. Rainfall.	10
4.	Thuringia. Soils.	11
5.	Thuringia. Agricultural zones.	14
6.	Czechoslovakia. Rainfall.	31
7.	Czechoslovakia. Agricultural zones.	33
8.	Hungary. Rainfall.	46
9.	Hungary. Seed production of legumes.	53

N.B.—It is assumed that for the political and physical geography of the part of Europe reviewed in this publication, reference will be made to an ordinary map of Europe, as for reasons of economy it was not possible to include more maps in this Bulletin.

INTRODUCTION.

This series of articles has been prepared with the object of giving readers of abstracts of European literature some idea of the application of the scattered results quoted from time to time in *Herbage Abstracts*. It is hoped that they will form a suitable background for the better understanding of the type and extent of fodder growing in various European countries, and the actual conditions of climate, etc., prevailing therein.

An opportunity to study the question in the three countries at present under discussion was given by a travelling grant from the Executive Council of the Imperial Agricultural Bureaux in June-July, 1933. A similar account of conditions in Holland is in preparation*, and it is hoped to extend the studies to other parts of Germany, Switzerland, Austria and the other European countries in which the cultivation of animal fodder in one form or another represents an important part of the national economy.

The most valuable factor in the preparation of these articles, and indeed in the conduction of the European part of this Bureau's work in general, has been the willing collaboration of acknowledged authorities in the various countries under review. The appreciative thanks of the British author and of the Herbage Bureau are here expressed for much valuable assistance and advice in this and other connexions.

---

*Owing to the complete reorganization of grassland research at present in progress in Holland, this particular account will be deferred indefinitely.—R.O.W.

SUMMARY.

The area of Central Europe under review is situated between E. Long. 10°-23° and between N. Lat. 46°-51°. In this area the type of fodder cultivation may be said to depend upon two chief factors, climate and elevation.

The two chief types of climate which exert an influence are the maritime (Atlantic) and the continental (Russian).

The mountains in the south of Thuringia are under the influence of winds from a westerly point, while the Thuringian Basin, in the rain-shadow of these high mountain ranges, has a predominantly continental climate.

The Moravia-Slovakia border in Czechoslovakia may be regarded as the eastern limit of the maritime influence. The winter climate of that country is intermediate between maritime and continental, the summer predominantly continental.

Western Hungary (Transdanubia) is at the eastern limit of the maritime influence, while eastern Hungary, comprising the great plain of the Alföld, has a continental climate, and is characterized by frequent occurrence of extreme conditions.

It is in the two chief continental areas, at low elevations and with rich soils, namely the Alföld and the Thuringian Basin, that the most important lucerne strains are to be found. The chief aim in the breeding work on these strains is the maintenance of high yield combined with the ability to withstand extreme cold and drought.

At the other extreme as regards altitude are the mountain pastures of Thuringia and eastern Czechoslovakia (Slovakia and Sub-Carpathian Ruthenia), where the economic problem is the substitution of the *Nardus stricta* and related poor quality swards by better quality grasses capable of persisting under these conditions.

Map No. 1. Area of Europe under review (with exception of Austria).

GRASSLAND AND FORAGE CROPS IN THURINGIA.

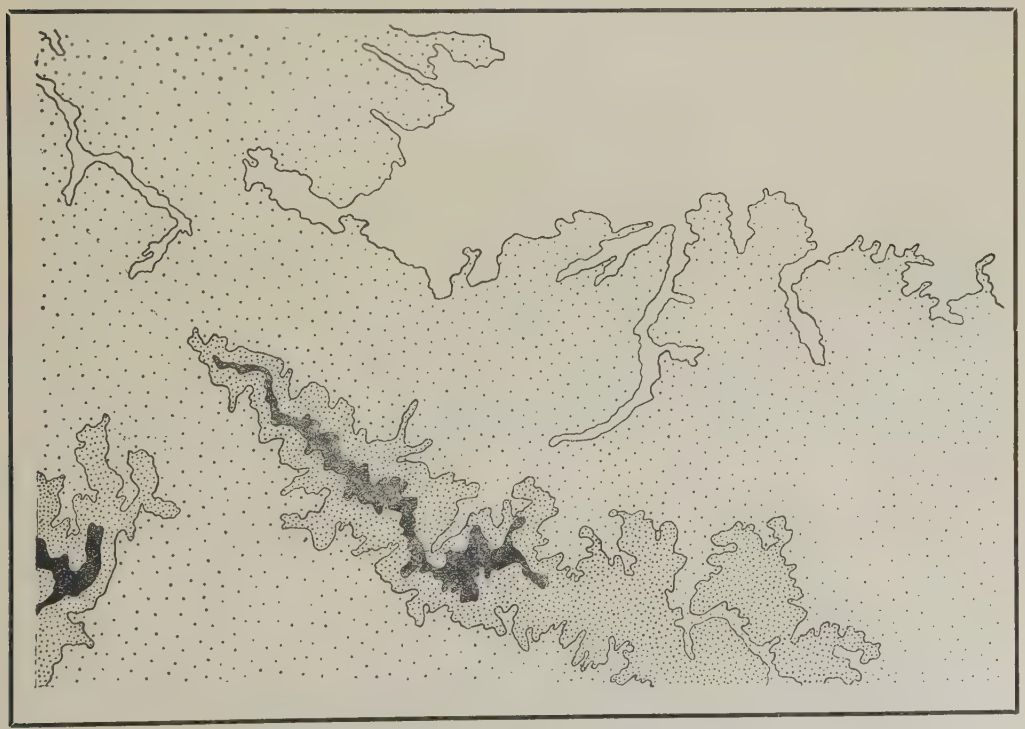
1. Physical factors and agriculture.
2. Agricultural zones in Thuringia.
3. Distribution of individual crops.
4. Anstalt für Pflanzenbau und Pflanzenzucht, Jena.
5. Some published results of research.
6. Associations and other bodies concerned with forage crops and grassland farming.
7. Bibliography.

1. Physical Factors and Agriculture.

The country ("Land") of Thuringia unites within its relatively narrow bounds quite considerable extremes of elevation, climate, geology and soil; therefore these various factors must be taken into consideration in any review of the agriculture. (Klapp **25**).

Relief.

The maximum difference in height between the Grossen Beerberg in the Thüringer Wald at 982 m. and the exit of the R. Saale towards the Leipzig-Halle basin at 95 m. amounts to almost 900 m. In the north of the country is the Thuringian Basin, the southern central portion of which is bordered by an almost unbroken mountain system composed of (from west to east) the Rhöngebirge,

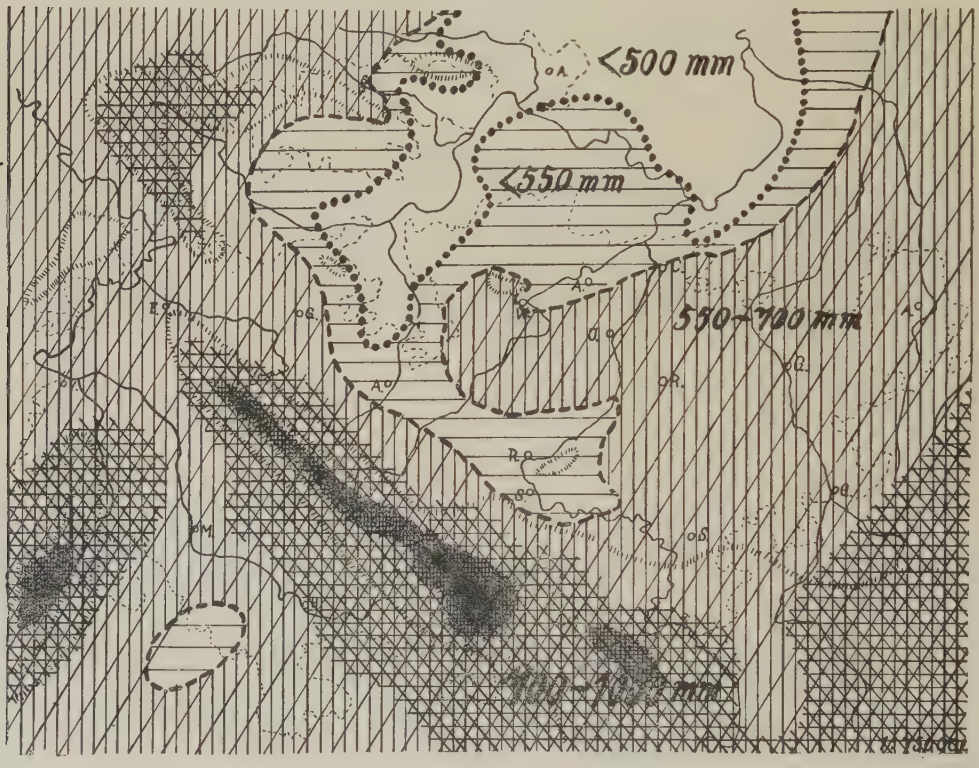


Map No. 2. Thuringia. Elevation. [from Wilmanns, Gärtner and Klapp.]
[Blank=under 200 m. Thin dotting=200-500 m. Thick dotting=500-700 m. Black=over 700 m.]

Thüringer Wald and Frankenwald. With all these extremes in elevation it is almost impossible to isolate even to a small extent their influence on the agricultural conditions, expressed mainly in climatic variation. It can be seen how variation in elevation generally goes hand in hand or indeed more or less converges with variations in soil conditions, so that relatively favourable or unfavourable climate, slope and soil frequently coincide. This on the other hand naturally makes isolated diagnosis of soil or climatic influences very difficult.

Rainfall.

Among the more important factors to be considered is the rainfall distribution (Map No. 3). The rain-bringing winds blow from the south-west, west



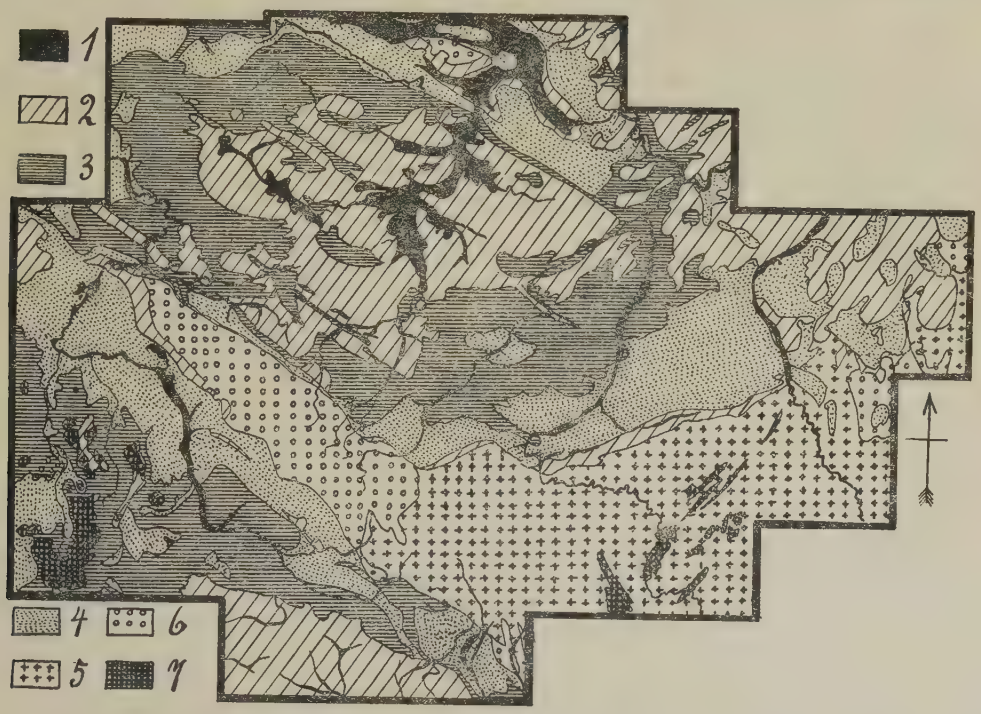
Map. No. 3. Thuringia. Rainfall. [from Wilmanns, Gärtner and Klapp.]
[Divisions: up to 500; up to 550; 550 to 700; 700 to 1000 mm.]

and north-west; as might be expected, they lose much of their moisture on the mountain ranges already mentioned, with the result that a well-marked rain-shadow develops on the northern and eastern sides of the systems. The semi-arid conditions in the most important of these dry zones, the Thuringian Basin, are due therefore to the influence of the Thüringer Wald and the Eichsfeld to the south-west and west respectively.

Soils.

The following are the chief soil types enumerated by Klapp (**25**). (See Map No. 4.)

(1) River valley loams of the larger valley flats, consisting of sandy slightly clayey lime-rich loams; in comparison with the other soils of Thuringia they are



Map No. 4. Thuringia. Soil. [from Wilmanns, Gärtner and Klapp.]
[For explanation of grouping by numbers, see text, pp. 11—12.]

richer in phosphoric acid, have a medium to large potash content and a high nitrogen content.

(2) Mild loam as distinct from the heavy clay soils of the lime district considered separately. This grouping is justified primarily by the uniformity of agricultural practice, which is characterized by the cultivation of high-yielding crops demanding good quality soils. The reaction is generally neutral to slightly alkaline; phosphorus content is average, available potash high.

(3) Lime soils, including all those soils of which the geological distinctions in origin are completely eliminated by their common characters of high lime content, neutral to alkaline reaction, comparative poverty in phosphorus, rich to over-rich potash content and clay binding. A common character is the difficulty of working when wet, and the manner in which they contract under drought. The wild flora and the weeds of arable and grassland are uniform in nature. From the agricultural point of view, the type of tillage depends upon the degree of the soil binding and clogging or on the stone content. This group includes the typical sainfoin soils, the areas for lucerne seed production, and on the steeper slopes most of the land formerly devoted to vineyards.

(4) Light soils which, although they have many characteristics in common, differ considerably in regard to origin and the petrological character of the original rock. Important characteristics include unsatisfactory moisture conditions, a reaction fluctuating between comparatively wide limits about a slightly acid mean, and fairly well-marked deficiency of phosphorus and potash. On the whole the group offers a sharp contrast to the mild loams of group 2, under very similar conditions of altitude, climate and water table. For this reason, forestry and the cultivation of the simpler crops predominate.

(5) Slate and greywacke detritus soils, in which the loamy clay binding material and high content of stone splinters and larger stones is in general a common characteristic. These soils are on an average definitely sour with a medium phosphorus-potash content; their agricultural utilization is greatly influenced and made comparatively uniform by the considerable altitudes. In consequence only the less exacting crops are grown. Raw humus strata are frequently detrimental under grassland.

(6) Soils of the lower Permian sandstone and conglomerates, including porphyry and other rocks of the Thuringian Forest. Except for woodland meadows and very small arable areas, this group is devoted to forests.

(7) Soils on basalt in the south-west, Rhön and foothills, and on diabase in the south-east. They are in general, poor in phosphorus and poor to medium-rich in potash.

Climatic, Geological and Soil Factors Summarized.

	High Rhön (Grassland).	Weimar-Jena district (Seed production of *Trifolium pratense*, *T. hybridum* and *Medicago lupulina*).	Central Basin (Lucerne seed production).
(a) Mean annual temperature C.°	5.0	7.5	8.2
(b) Mean annual rainfall in mm.	950	560	490
Minima and maxima	(700—1200)	(500—650)	(460—520)
(c) Rain factor (b : a) ..	190	75	61
Character of climate ..	humid	semi-arid	semi-arid
Amount of rainfall in the separate months:			
January	92	38	32
February	75	28	27
March	71	37	30
April	61	40	32
May	70	55	57
June	69	57	50
July	83 } 317	80 } 250	66 } 214
August	96	60	53
September	69	53	45
October	72	39	37
November	82	36	32
December	70	37	35

Predominant soil type ..	Slightly podsolized soils.	Loess, Rendzina, Brown earth.	Loess, Black earth (Chernozem).
Geology	Basalt (Tertiary).	Shell limestone. Keuper Diluvial.	Keuper Diluvial.
Soil character	Poor, sour, stony loam.	Rich (especially in potash), lime and loam soils.	Rich humus loams.
Elevation in metres	600—800	250—400	150—250

Vegetation.

A comparison of the general distribution limits of some extreme plant associations (Map No. 14 in Wilmanns, Gärtner and Klapp **25**) affords an insight into the contrasts to be found in the vegetation of Thuringia. The low-lying flat lands of the Basin show extensive development of the steppe heath plant associations. These are the warmest and lowest rainfall regions with preponderantly neutral to alkaline soils. These alkaline soils under similar climatic conditions are frequently substituted by slightly to definitely sour soils in the Altenburg lowlands, and the strongly marked shallow soil slopes with a rocky subsoil are considerably more rare ; this may be among the principal reasons for the absence or the marked retreat of the steppe heath flora in this area. From an agricultural point of view, this Basin area corresponds to an agricultural region in which the favourable co-operation of climatic and soil conditions is plainly expressed in the wide cultivation of malting barley and sugar beet. Here also lucerne finds its suitable habitat and the lucerne seed production is exclusively confined to this area. Meadows are almost or totally absent.

Very marked differences are found between the wild and cultivated floras of the Thüringer Wald, Rhöngebirge and Frankenwald on the one hand and the continental Basin lands on the other, although the distance between them may be insignificant. These high levels are distinguished by the typical development of well-marked mountain meadows, including the so-called Rhönhuten. It is grassland with the following principal plant stands : *Agrostis vulgaris* and *Festuca rubra* according to the local conditions and in particular to the presence of raw humus layers, more or less strongly intermingled with *Nardus stricta, Aira flexuosa, Carex leporina, Calluna, Vaccinium* spp., and *Galium saxatile.* While sward associations with these components extend to lower levels, the high montane meadows of the Rhöngebirge, Thüringer Wald and Frankenwald maintain a special character through the occurrence, either general or limited to a particular district, of *Arnica montana, Centaurea pseudophrygia, Crepis succisifolia, Geranium silvaticum, Meum athamanticum, Phyteuma orbiculare, Poa sudetica, Ranunculus nemorosus, Thesium pratense* and *Trifolium spadiceum.*

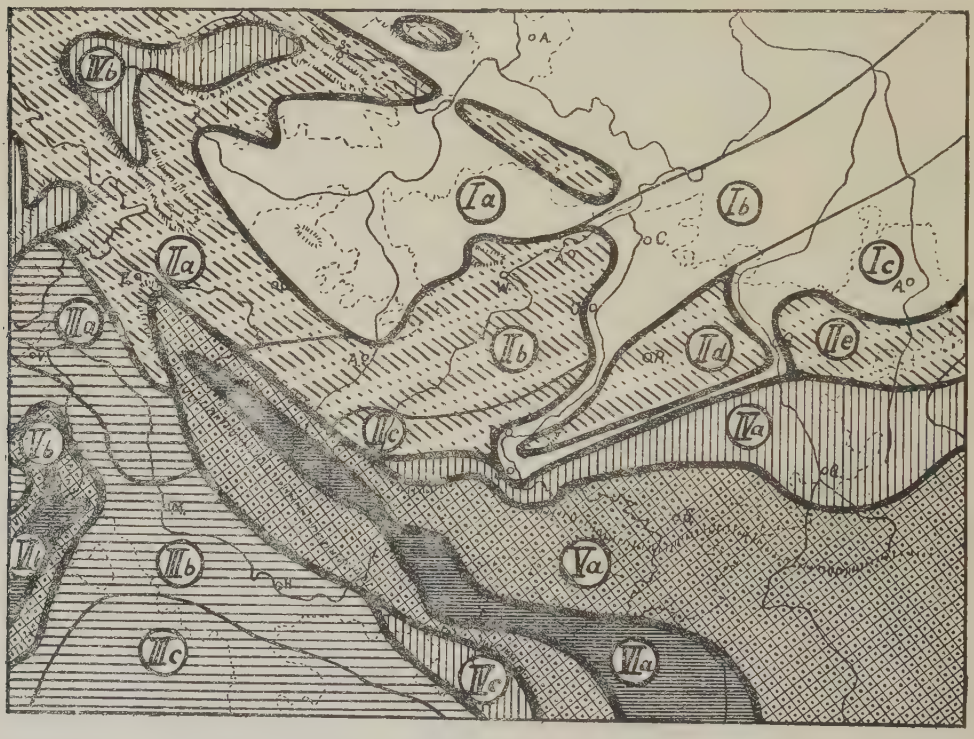
Particularly in the Rhöngebirge are wide areas covered with an unbroken carpet of this type, while the relatively frequent large forest clearings of the remaining mountain lands carry similar swards. In most cases these fields yield only one cut and aftermath ; they have not been used as yet for alpine pasture management. These paddocks react in the trials situated therein remarkably strongly and favourably to cultivation and manurial management. In places, particularly in the Thürin-

ger Wald, the whole organization of the agricultural management is strongly impressed by the necessity for the production of fodder and grazing on these alpine grasslands. Here occur the lowest temperatures, short summers, highest rainfalls together with preponderantly sour soils frequently covered with humus layers. Further, this area is agriculturally notable for the quite complete disappearance of all exacting cultivated plants, by the prominence of the potato and oats as the most reliable crops, the replacement of winter rye by summer rye, and similar characteristics. In particular, the potato here exceeds 60 per cent of the cultivated land in certain districts.

2. Agricultural Zones in Thuringia.

Klapp (**25**) recognizes six agricultural zones in Thuringia, classified on the following basis (Map No. 5).

Zone No. 1. This includes land suitable in almost every respect for arable cultivation, with the lowest percentage of forest and meadowland, and the highest percentage of wheat, summer barley, sugar beet and lucerne. The rainfall distribu-



Map No. 5. Thuringia. Agricultural zones. [from Wilmanns, Gärtner and Klapp.]
[For explanation of grouping by numbers, see text, pp. 14—15.
Grouping by letters to be disregarded.]

tion is favourable because of its low absolute quantity, in so far as there is a well-marked early summer maximum. The zone embraces the Central and North Thuringian Basin with the Altenburg lowland, the indented valley of the Saale, Elster and the uniting Orla Basin.

Zone No. 2 consists of a more or less broad girdle around the first zone. The majority of this second zone lies on the lee side of the Thüringer Wald and the remaining marginal heights of the Basins, and may be described in general as a foreland of the middle and high mountain levels. In it lie the upper limits of profitable sugar beet cultivation and also of good quality barley; wheat can be cultivated throughout the entire zone with satisfactory results.

Zone No. 3. This represents a counterpart of zone 2 on the south-west side of the Thüringer Wald and in the lee of the Rhöngebirge. It should, however, be remembered that the average height is greater than in the preceding zone, the amount of rainfall is somewhat greater and the average yearly temperature is slightly lower. Material phenological differences from zone 2 do not exist, but the climatic conditions on the whole have a less continental character than those described for that zone.

Zone No. 4. This can be subdivided into several not quite equivalent widely separated areas with quite definitely similar climatic conditions. Here spring is later by seven days and the rye harvest commences twelve to fourteen days later than in the favourable zone 1. In addition the decline in the average annual temperature as compared with zone 3 is evident.

Zone No. 5. Here are included definite sub-montane levels with a rainfall which is above the average for the whole of Germany. The results of this fact are seen not so much in a delay in the coming of spring as in a retardation of the harvest as compared with the above-mentioned zones.

Zone No. 6. This comprises the ridges of the Thüringer Wald and the Rhöngebirge, averaging 550 m. and upwards. The rainfall reaches or exceeds 900 mm.; the average annual temperature is 5°C. and under. The coming of spring is 10-14 days later and the rye harvest commences 25-30 and more days later than in the Thuringian Basin.

3. Distribution of Individual Crops.

Data are available regarding the actual distribution of the crops cultivated in Thuringia, such as winter and summer rye, winter and summer wheat, winter and summer barley, oats, pulses, potatoes, fodder and sugar beet and beet seed production. A few references to grassland, clover and lucerne will suffice for the present purpose.

In the lower localities the greater grassland areas are determined by situation above the ground water level quite independent of climate; as elevation increases, rainfall and diminishing temperature (here often independent of subsoil water or danger of flooding) become more prominent as governing factors.

The absolute extent of the clover area is governed by a whole series of factors of varying effect. It is found mainly where for one reason or another lucerne cannot be grown, i.e. in the Frankenwald, in the Rudolstadt and Stadtroda, new red sandstone areas, and in the remaining north-east part of Thuringia.

The distribution of lucerne is exactly the opposite of that of red clover; it is found mainly in the Basins and the shell limestone elevated borders. Further, it may be found in all places where the lime soils of the soil group No. 3 recognized by Klapp (see soil section) are sufficiently deep. The shallow and more stony lime soils are occupied by sainfoin (*Onobrychis sativa*); in exceptional cases this crop is also grown as an animal fodder on the best soils of the Basin. Towards the Altenburg lowlands there is a considerable diminution in lucerne growing, presumably again for reasons of lime-deficient soils and perhaps also because of increasing rainfall. Again, lucerne is almost entirely absent in the sandstone areas; in the Werra it is absent only on these soils. Neither is it to be found where the rainfall exceeds 700-800 mm., although where the precipitation is not so high, the crop may grow at quite considerable elevations on suitable soils.

4. Anstalt für Pflanzenbau und Pflanzenzucht, Jena.

General.

The Institute for Crop Cultivation and Plant Breeding of the University of Thuringia, Jena, does not confine its activities to the zone of operations covered by this article. It is fundamentally concerned with all cultivated plants of value to the country. With cereals it is confined more particularly to exact trials of varieties, carried out on the University's Dornburg Estate. Extensive permanent manurial trials with wheat, barley, sugar beet and potatoes are also carried on here. Naturally, also, a large selection of all cultivated plants is kept.

The chief work of the Institute is, however, potato and grassland research. Here is situated one of the two investigation stations for the Kartoffelsorten-Register (Synonym-Committee). The principal work with potatoes relates to the study of the so-called ecological deterioration, for which purpose continuous reproduction trials at 25 different stations in the country are of service as well as the trials at Zwätzen. Also attached to the Institute is the so-called Potato Trial Station, the work of which consists in the carrying out of a large number (40-60) of annually repeated variety trials with a view to ascertaining the varieties of potato suitable for the different parts of the country. These trials are connected with meteorological, phenological and ecological observations, and finally a study is made of the weeds associated with the potato, not only those growing in the fields, but also those on the edges of the fields and in neighbouring meadows.

The Chief Station for Plant Protection (phytopathology) is also attached to the Institute. This section also collaborates in the botanical and grassland research in so far as it is particularly concerned with the execution of the control trials with *Colchicum autumnale* and other weeds.

According to the time of the year and to the means available from four to eight academically qualified workers are appointed, not including the secretary, temporary stenographers, and the technical assistants (from three to five) in the Institute itself. For the trial grounds at Zwätzen from twelve to eighteen women and a man to drive horses are appointed, the number varying according to time of year and demand.

Grassland and forage crops.

The work on grassland and fodder crop research can be separated into that which is carried out on the trial ground at Zwätzen and that which is carried out at various stations in the country.

Experiments at Zwätzen.

(1) Lucerne. The question of origin is, after trials of many years' duration, considered to have been elucidated, as well as the question of the suitable method of sowing, with or without a cover crop.

The most important of the agricultural questions under investigation is the best time and frequency of cutting, with special regard to (a) highest hay yield, (b) highest protein yield, (c) highest protein content, and (d) best over-wintering and persistence.

Trials of this kind have been carried on at two other places in addition to Zwätzen for a period of four years, and finally with strains of various origin also. These are now considered to be finished, and at present only the after-effect on over-wintering, weed contamination and aftermath is being tested. Some results are described later. Here belongs also the test which is still in progress on the influence of light as compared with severe grazing of lucerne.

The problem of origin will be further studied in the form of the International (Belovic) variety test (Whyte **24**). Great emphasis is laid on the testing of the best seed production processes, namely, the collection of the 1st, 2nd or 3rd cuts for seed, the use of widely-spaced rows or individual planting, and finally the supporting of the

plants with twine which is drawn through various types of frames. The results of the individual methods change markedly each year, but success has been attained through their combination in a regularly good seed yield for the past six years. Thuringian lucerne appears to be to a large extent independent of insects for fertilization and to be chiefly influenced in seed setting by change in sun and shade.

The breeding work on Thuringian lucerne is based upon the fact that the modest requirements and the performance of this strain depend upon its hybrid character. Therefore it is considered correct to maintain this hybrid character, which is expressed in a great variety of habit and flower colour. The Station works therefore with a large number of parent plants which have been selected from 80 Thuringian strains. The descendants of these parent plants are tested only in a simple manner. The adaptation of Thuringian lucerne to the most important parts of the country is left for the greater part to natural selection, in such a way that at the present time 12 varieties as well as mixtures of seed of the best mother plants are sown in the field under varying soil and climatic conditions; individual descendants are sown out and finally individual plants are planted out. Naturally varying groups of the best plants will be produced according to local conditions. From the mixed sowings the less suitable plants will be gradually eliminated, and so on.

An important question is the planting of the poor stony mountain slopes, which have hitherto been considered as infertile, with a low-fertility-demanding lucerne for purposes of seed production.

(2) Sainfoin and other fodder plants. The variety trials and breeding which were to have been conducted at Zwätzen had unfortunately to be abandoned, as the fruits were without exception destroyed by a gall midge (*Contarinia loti*). As this insect also does great damage in the lucerne seed production area of northern Thuringia, a so-called " flying station " of the Biologischen Reichsanstalt für Land- und Forstwirtschaft, Berlin-Dahlem, has been established, at present under the direction of Dr. Lehmann, to study its biology and the possibilities of its control; the first report published by this station deals with the life-history, extent of damage and the control of *Phytonomus variabilis*, *Sitona lineata* and *Apion pisi* (Lehmann **17**). Of sainfoin therefore only a varietal test is maintained and attempts are made to establish suitable mixtures containing this very important species in the country.

Newly included in the work of the Institute is the collection of and breeding work on the highest possible number of types of *Medicago lupulina*, *Trifolium pratense*, *T. hybridum* and *Vicia* spp. from Thuringia, of which little can yet be said. In addition, approximately 25 of the most important fodder plants are annually tested for yield under local climatic conditions (maize, Sudan grass, *Helianthus annuus*, *H. tuberosus*, *Panicum* spp., sorghum, and so on).

(3) Grassland trials proper at Zwätzen.
- (a) manurial treatment of many different kinds;
- (b) different methods of tillage and cultivation;
- (c) grazing;
- (d) formulation of seeds mixtures;
- (e) rate and time of sowing;
- (f) influence of time of cutting and manuring on old and newly sown meadows;
- (g) different white clover varieties in pasture mixtures under grazing.

Experiments in other localities.

I. Five large meadow trials. The scheme is in general the same everywhere, namely :—

(a) untreated ;
(b) manuring with P_2O_5 and K_2O ;
(c) ,, ,, ,, ,, and N ;
(d) ,, ,, stable manure ;
(e) ,, ,, liquid manure ;
(f) covering with potato stems, straw, etc.;
(g) manuring with compost (waste products and earth) ;
(h) cultivating with roller ;
(i) ,, ,, scarifier ;
(k) sowing with combined scarifier—drill machine ;
(l) breaking up, with a 2-year between-crop of oats and potatoes, and new sowing down.

On the Rhön and in the Frankenwald all the methods a—l have also been carried out with and without liming. The trials in progress since 1928-30 are at the stage in which the newly sown-down areas have yielded 2-4 harvests according to the age of the trial. Below are given the average results of the most important plots of the combined trials :—

(a) untreated = 100 ;
(b) scarified = 98 ;
(c) roller = 99 ;
(d) new sowing with scarifier and drill machine = 102 ;
(e) compost = 125 ;
(f) $P_2O_5 + K_2O = 125$;
(g) stable manure = 160 ;
(h) $P_2O_5 + K_2O + N = 162$;
(i) liquid manure = 172 ;
(k) new sowing = 184.

On an average, liming increased the yield by 8 per cent, but the influence of lime is, especially at Klings, at times decidedly greater. The yield of (k) shows throughout a falling tendency.

II. Continuous botanical studies of meadow and pasture manurial trials.

These are conducted under the auspices of the Landesbauernschaft (formerly the Hauptlandwirtschaftskammer), the Thuringian Land Drainage and Irrigation Works, and the Fertilizer-Syndicate. The study of about 70 trials which were investigated in 1930-32 has now been discontinued. At the present time eight exact meadow manurial trials and three pasture manurial trials are still being studied.

III. Botanical investigation and yield determination :

(a) on about 200 new sowings of clover-grass mixtures, which were sown down in the high parts of the Thüringer Wald in place of uneconomic potato cultivation (on behalf of the Thuringian Ministry of Economics) ;
(b) on 5 trials with various mixtures of *Onobrychis sativa*, *Lotus* and grasses on poor, stony shell limestone soils ;
(c) on 35 trials with overwintering field fodder mixtures,
    (i) *Vicia villosa* and *V. pannonica.*
    (ii) *Trifolium incarnatum.*

These trials are generally carried on jointly with the Agricultural Schools and and the State Economic Advisers.

IV. Ecological, sociological and economic studies on over 400 meadows and about 300 pastures. (On behalf of the Thuringian Ministry of Economics, the Crop Cultivation Stations, the Agricultural Schools, etc.).

In place of the usual investigation of plant sociology there is made exhaustive botanical study and test of soil and ground water conditions, as far as possible five or six times. This work is now considered as completed, but the working out of the data is not yet finished. Parts of this work are described in publications from Jena under the title of " Wiesen und Wiesenpflanzen in Mitteldeutschland." (See under head : " Ecological, sociological and economic grassland studies." p. 25.)

Special objects of these investigations were :

(a) the judging of marshy areas preliminary to improvement and the observation of the results of that improvement ;
(b) the observation of damage due to salts of natural (salt springs of North Thuringia) and industrial origin (effluents of the potash factories).

V. The trials on the control of *Colchicum* and Umbelliferae have already been mentioned.

VI. Trials on ecotypes of grass and clover species as defined by Turesson have been instituted.

Special emphasis is laid upon the fact that the Institute is always generously assisted in its work by the Thuringian Ministry of Economics, the Land Drainage and Irrigation Works, the Directors of the Agricultural Schools, the independent Economic Advisers and the representatives of the Fertilizer Syndicates.

---

5. Some Published Results of Research.

Consideration will now be given to some results of the various research items, enumerated in section 4 of this account, which have already been published. These will be dealt with briefly in the same order as they were mentioned in the foregoing section.

The Thuringian strain of lucerne.

The most important strains of lucerne cultivated in Germany are the Old Franconian and Thuringian. Both are the results of hybridization between *M. sativa* and *M. falcata*, and from the former has arisen the Grimm lucerne of North America. The introduction of *M. falcata* into the Franconian strain has enabled it to extend further throughout the zone of its cultivation, and to invade the Keuper soils. In former times (Klinkowski **16**) it was the *M. falcata* proportion of the Old Franconian lucerne which was constantly on the increase, but to-day the movement is reversed. The more the *M. sativa* characters predominate, the less becomes the winterhardiness and the shorter therefore the duration of a stand. The subsoil, moreover, is less advantageously utilized, since the *M. sativa* type has less branched roots. As has already been noted, it is precisely these valuable hybrid characters which are the object of research on Thuringian lucerne at Jena and in the neighbouring district.

A complete study of Thuringian lucerne has been made by Klapp and Schubart (**6**), who stated that the strain originates from the scene of the earliest cultivation of lucerne in Central Germany, the centre of the Thuringian Basin, where *Medicago*

falcata occurs in abundance. It is a typical hybrid lucerne related to Franconian, the percentage of plants with violet flowers being seldom more than 50 per cent, the remainder having flowers of white, yellow, greenish-white and other colours.

A comparison of Thuringian lucerne with Southern strains shows the following differences : Thuringian lucerne has a darker leaf colour, more spreading habit, more marked root branching, higher yield, and a greater degree of resistance to cold and disease. Its growth is at first slower, then more rapid than that of the Southern strains. The total yield of Thuringian in the year of sowing was less than that of Southern strains, but in subsequent years surpassed the Southern yield, increasing after each winter. A comparison of individual cuts showed that it is the first cut of Thuringian lucerne in which this increase is most plainly marked, whilst under normal summer conditions the Southern strains give a better second and third cut. Thuringian lucerne gives a better seed yield.

7,180 individual plants of 71 Thuringian strains were studied for flower colour, green yield and pod proportion. The average figures for flower colour were 40.5 per cent distinctly violet, 20.6 per cent red and 38.9 per cent " hybrid-coloured." As the ratio of hybrid-coloured flowers within the respective species increased so did green yield to a marked degree, and the pod proportion less markedly. Certain strains, some of which have been already noted by Stählin as non-indigenous, were distinguished by differences in flower colouring. Differences in green yield and pod proportion were more or less clearly correlated to one or other group of flower colours. The soil type from which a strain originates appears to have an influence upon green yield.

A study of individual plants led to the following conclusions :—In studying strains of different origin, it was found that the pod setting of strains with a large proportion of violet flowering plants was poor ; in a study of the individual plants the best average pod setting was found in the violet flowering plants. (The contrary is the case with Southern strains.) In agreement with Lieber's supposition, it may be assumed that in German hybrid lucernes hybrid forms with violet flowers also play a part. The lowest average rate of pod setting was found in the white flowering plants. Plants with the most marked hybrid colouring, violet yellow, green yellow, and finally pure blue, led with respect to average green yield. Pure yellow and pure white flowering plants had the lowest green yield. As a rule the average capacity of individual plants in regard to green yield and pod setting diminished in each of the main colour groups in proportion to the diminution of colour intensity ; it was, for example, less in the pale blue flowering plants than in the dark blue. It was also found that the pale blue flowering plants, once they attained a high degree of pod setting, gave at the same time a particularly good green yield, and vice versa, so that from this group were obtained plants of the greatest and also of the lowest agricultural value. The positive correlations between green yield and seed yield found by Iffland (*vide infra*) were clearly seen here as regards pod setting, most notably in the more pronounced hybrid types, and least in the violet flowering plants. The strain with an increasing proportion of " hybrid-colour " flowering plants is proved to be of increasing value as regards green yield and pod setting.

Stählin (**22**) examined seventy-four seed samples of Thuringian origin for (1) thousand grain weight, (2) foreign matter in general, (3) foreign matter after removal of good clover species, (4) weed content. The dominance and frequency of the individual species was ascertained. Seed was generally obtained from the first cut, but seed from the second cut showed a decrease in number and weight of weed species. Less red clover seed was found in seed from older stands. The use of older stands for seed would tend to influence longevity.

Iffland (**2**) studied Thuringian, Franconian, Italian, Provence, Hungarian, Cossack and Grimm lucernes with reference to flower colour, leaf form and colour, growth habit, proportion of stem, plant weight, seed weight, growth rhythm, stand density, disease resistance, and winterhardiness. The relation between the above characters and seed yield was an important part of this study.

Schubart (**20**) used the same material (Thuringian, Old Franconian, Grimm, Cossack and Provence) in a further study of the mutual relations of productivity and morphological characters with special reference to seed yield.

In a study of the climatic basis of lucerne seed production in Thuringia, Paulssen (**18**) observed that the local farmers were disinclined to use indigenous lucerne seed owing to its higher initial price, in spite of its superiority in longevity. In Thuringia and throughout Germany consumption of lucerne seed greatly exceeds production. The temperature and weather conditions of Thuringia would appear to be suitable for extensive seed production of lucerne. It has already been noted that questions relating to seed yield and production of lucerne are receiving particular attention at the Zwätzen Experimental Farm of the Institute of Crop Cultivation and Plant Breeding in the University of Jena. Klapp (**10**) has recently summarized the results of five years' experience on some aspects of seed production, more especially for practical readers ; the following are some points to which reference is made.

(1) Only indigenous strains are suitable for seed production. (2) When a plot has been used for seed production it should next be used as a forage crop, otherwise seed yield diminishes considerably. (3) There are both advantages and disadvantages connected with the choice of the first or the second cut for the seed crop, but a certain amount of security may be ensured by taking the seed from the stand at different stages of development, i.e. some from the first cut ; some from the second cut, partly after the usual first cut, and partly after an unusually early first cut (when the crop is 20 to 25 cm. high), and even on occasion after two very early green cuts. (4) No good purpose is served by growing the plants far apart unless the stand is old enough and developed sufficiently to utilize the space. One method of obtaining this is to drill in the crop at the customary distance, using it in the seeding year for fodder ; to hoe lightly in the second year, using the crop partly for fodder and partly for seed production ; to hoe heavily in the third and fourth years, finally thinning out every other row, different parts of the field being used for fodder and seed production respectively from first and second cut alternately. The plants are thus strengthened by the time the desired planting distance is obtained, two consecutive seed harvests have been avoided, and in addition the greatest possible quantity of fodder is produced. (5) The prevention of lodging by tying up the plants seems to procure, certainly not the largest, but the most reliable seed crops. The practical farmer may be recommended to try this on a small scale as soon as further information with regard to the cost and success of using twine and wire stands is available. (6) Above all it must be clearly understood whether the crop is to be grown for both forage and seed or whether it is to be devoted to seed production alone. Only in the latter case are planting out and wide drilling (50 to 80 cm. apart) recommended in addition to the measures already described.

Other studies of Thuringian lucerne have been concerned with the choice of pure sowings or nurse crops (Schubart **21**), the yield and protein content of lucerne as affected by varied frequency of cutting (Klapp **11**) and an investigation of the protein yield of lucerne, in connection with the recent German emphasis on the growing of protein-rich fodders. Larger supplies of protein may be obtained from lucerne hay than from red clover hay, not because the actual protein content of lucerne is higher, but because its rapid development and powers of recovery enable it to tolerate early and frequent cutting, and therefore full advantage may be taken of the high protein content of the young crop. (Klapp **12** and **15**).

Sainfoin (Onobrychis sativa).

This crop is not of such great agricultural importance in Thuringia as the local lucerne variety and does not therefore receive so much attention. Deffner (**1**), in a review of various aspects of its cultivation in that country, notes that the crop follows only those geological formations in which the soil has at least an average lime content and a pH value of 6.0 and over. It is cultivated in districts up to 600 m. above sea level with an annual precipitation of 450 to 1100 mm., and will grow on heavy and clayey soil provided the characters mentioned above are present. Yield and duration of crop are governed largely by soil type. The plant usually dies off after two years where the subsoil is wet. It has a higher lime requirement than lucerne.

The two-cut sainfoin, which always forms stems and (in good soil) leaves a few weeks after the first cut, and invariably flowers a second time, can be grown successfully only in good soils. Here it is superior to the one-cut sainfoin, which under favourable circumstances may certainly give a flowering second cut, but does not grow so high and has shorter panicles than the two-cut. The two-cut sainfoin requires greater soil fertility than the one-cut, and is of shorter duration in all soils.

In outlying districts at considerable height, where lack of transport facilities makes it difficult to increase soil fertility sufficiently for lucerne growing, sainfoin is cultivated with success.

The decrease in the duration of sainfoin during the last ten years and the occurrence of " sainfoin sickness " may have been governed by the increase in soil fertility, or on the other hand by the mixing of strains due to the import of foreign seed unsuitable for local conditions.

Mountain pasture and meadow trials.

The results obtained to date from the various treatments of the mountain pastures and meadows have already been stated (see p. 18). One of these trials is situated in the Rhöngebirge, one in the Thüringer Wald, one in Frankenwald, and two in the shell limestone highlands of the Saale district. Brief mention may now be made of the type of grassland upon which the first of these trials (in the Rhöngebirge) is proceeding (Klapp **3**).

In the Rhön the pastures are 180 m. higher than the villages and 2.5 km. away on the average. The rainfall decreases from 800-900 mm. in the south to 700 mm. in the north. The maximum rainfall is attained in the summer, during the months of July and August. At Frankenheim, one of the villages whose pastures are being studied, the average annual temperature is 5.1°C. (January average= -3.3°, July=14.1°C.). In these situations, with exceptions, only the months of July, August and September are certain to be without frost or snowfall.

The combined effect of geological origin, weathering, influence of climate and water relations, and finally the former and present vegetation produce soil conditions as follows : common to the weathered basalt soils is the loamy to loamy-clay character frequently with insufficient permeability, but with quite favourable physical conditions for grass growth ; the surface layer may be changed by inclusion or superposition of humus substance. While in nature the raw humus residue of the heath formation predominates in the drier areas, on the moister areas and in marshy places are found the more or less decomposed remains of sedges, mosses, etc., without the last-named areas acquiring a well-marked moor character. The soils on the plots studied are to be regarded as about one-fifth weak humus, three-fifths strong humus, and one-fifth humus soils, with a marked lack of mineral substances. Only in places can one speak of the really favourable character of these humus admixtures ; the heath areas of former times and those still in existence show the unfavourable

effect of raw humus soils on the composition and performance of a grass sward. The extraordinarily wide occurrence of large stone boulders on the basalt soils is also to be emphasized.

Thirty-five soil samples were studied for their nitrogen, phosphorus, potash and lime content, and for their pH value which varied from pH=4.3, to pH=6.5.

Thirty-three per cent of the agriculturally valuable land at these altitudes comprises meadows and pastures, 9 per cent fodder plants, and 34 per cent cereals. The valley meadows are well-watered, even to water-logging. The yield from this land is frequently qualitatively poor, although quantitatively far above the average. Certain of the meadows on the mountain slopes equal the average in yield for Germany, whereas the average yield of the mountain grassland used for hay probably does not exceed 20—25 dz.* per ha. or half the average for Germany. The quality, however, ranks higher. The mountain meadows and pastures comprise 2,500 ha. of which about three-fifths are the " Rhönhuten " proper, which are characterized by their situation on the high areas and summits of the Rhön, generally over 500 mm. above sea level.

For purposes of estimating the agricultural value of these swards, the following yield classes are recognized. One doppelzentner of poor hay is reckoned as ½ dz. good hay ; a dz. average quality hay as ¾ dz. good hay.

Yield class 1.	10	dz.	per	ha.	poor	hay	=	5	dz.	good	hay.
2.	20	,,	,,	,,	,,	,,	=	10	,,	,,	,,
3.	20	,,	,,	,,	average	hay	=	15	,,	,,	,,
	30	,,	,,	,,	poor	,,	=	15	,,	,,	,,
4.	30	,,	,,	,,	average	,,	=	22.5	,,	,,	,,
5.	30	,,	,,	,,	good	,,	=	30	,,	,,	,,
	40	,,	,,	,,	average	,,	=	30	,,	,,	,,
6.	40	,,	,,	,,	good	,,	=	40	,,	,,	,,
	50	,,	,,	,,	average	,,	=	37.5	,,	,,	,,
7.	50	,,	,,	,,	good	,,	=	50	,,	,,	,,
8.	60	,,	,,	,,	good		=	60	,,	,,	,,

The various grassland areas were subdivided by Klapp (loc. cit.), who gives the characteristics of each group as regards quality, soil conditions and botanical composition.

1. Unimproved or slightly improved areas.
   - A. Unimproved boulder-fields with marked heath formation (*Calluna vulgaris—Nardus stricta* (32.5—13.5—54.0—33.8 ; 45—55).†
   - B. Little or non-improved dry pastures with less heath (34.4—20.6—45.0—5.17 ; 61-39).
   - C. Improved, formerly with much heath, slightly manured areas (55.7—18.9—25.4—9.5 ; 64—36).
   - D. Improved poorly manured *Trifolium spadiceum—Nardus stricta* areas of average dampness (30.0—35.3—34.7—9.3 ; 66—34).
   - E. Wet to marshy areas which have not been improved or which have not reacted to treatment (58.7—1.9—39.4—16.1 ; 46—54).

---

*Doppelzentner=2 cwts.

†Figures represent (Grasses—Leguminosae—Other species—Spaces or moss ; valuable and useful species—unpalatable species of inferior value).

These five unimproved types of grassland (A—E) are classified for yield as follows :—

Grassland type.	Yield class.
A.	1
B.	Mostly 2.
C.	3, occasionally 4
D.	3
E.	2—3

2. The improved pastures are also subdivided into groups.

F. Dry improved pastures and mown areas, *Festuca rubra—Agrostis—Avena pratensis* (69.6—10.5—19.9—2.8 ; 76—24).

G. Dry to average *Festuca rubra—Agrostis* areas (66.2—18.1—15.7—1.1 ; 87—13).

H. Dry to average *Festuca rubra—F. pratensis—Poa pratensis* mowing areas (66.6—18.0—15.4—3.7 ; 87—13).

J. Average moisture, clover-rich, *Festuca rubra—Cynosurus cristatus* pastures (59.0—30.6—10.4—1.0 ; 95—5).

L. *Trisetum flavescens* areas (76.3—13.7—10.0—1.8 ; 86—14).

M. Moister areas of *Agrostis—Poa pratensis—Festuca rubra—Alopecurus pratensis.*

These groups are classified for yield as follows :

Grassland type.	Yield class.
F.	6
G.	5—6
H.	5—7
J.	7—8
L.	7—8
M.	7—8

Mechanical treatment of grassland.

Klapp (**8**) has reported on the results of trials on mechanical treatment of swards on mineral soils at altitudes varying from the experimental fields at Zwätzen to the higher points of the Rhöngebirge. Improvement was attempted by means of (a) scarifying, (b) scarifying and drill sowing, (c) rolling, (d) scarifying and rolling, and (e) scarifying, drill-sowing and rolling. It was concluded that none of the processes adopted gave a really satisfactory result from a technical point of view, and still less from the economical aspect. Good after-effects may be produced in subsequent years, but at too great a cost.

Ecological, sociological and economic grassland studies.

As already stated in this article, the results of these investigations are being published under the general title " Wiesen und Wiesenpflanzen in Mitteldeutschland."

The first of the three articles already published under this title deals with a sociological study of thirty-two meadows with a diminishing proportion of *Bromus erectus* (Klapp **5**). The association occurs in Central Germany, with a very constant composition on neutral to slightly alkaline soils, generally poor in phosphoric acid, rich in potassium and carbonate and often rich in nitrogen, but always in dry and sunny localities. The yield of these meadows, mostly rich in grasses and free from weeds, is about 24-28 cwt. per acre below the average; since the presence of the association is governed by dryness of locality and not deficiency of nutrients, such areas are not so amenable to fertilizers as has been hitherto assumed. The addition of fertilizers can, however, improve yield considerably, particularly in intermediate meadows where the *Bromus* proportion is not so great. Where breaking up is technically possible, it is frequently more profitable to use the land for arable crops, but where the soil is too shallow and stony it should be reserved for grassland. Although the performance of the association will never be high, it will be steady and attainable practically without care or manuring.

The second article of this series (Stählin, Wagener and Klapp **23**) is concerned with the presence of Umbelliferae in meadow stands, and considers principles, importance and control. It was found that Umbelliferae are present in meadows in quite different forms and to quite a different degree in accordance with the combined effects of sexual and vegetative reproduction, growth habit and external influences. At least one-third of all the meadow stands studied on the better soils contained more than 10-20 per cent Umbelliferae. Their composition in comparison with grasses in particular is distinguished by the very high water content of the green leaves, by lignification of the stems and by high nitrogen and mineral content of the dry matter. The yield capacities of the principal species is great, and the yield of meadows of a certain type generally increases according to the proportion of Umbelliferae present.

The remainder of this article deals with toxicity, weed character, incidence of Umbelliferae in 410 Central German meadows and the associations in which they are found, chief requirements of the individual species and the characteristics of twelve species, based upon statistical, ecological and economic findings. The success of direct, indirect, and preventive control is governed by the specific form of competitive ability, by the persistence, manner of reproduction, period required for growth, root system and general requirements of the different plants. Among the various treatments adopted, grazing gave the most reliable results, accounting for the almost complete disappearance of the Umbelliferae. The time taken to suppress them appears to be dependent, however, not only upon the intensity and duration of the grazing, but also upon the natural herbage productivity of the locality. The most rapid means of control is several years of repeated stocking to the full capacity of the land.

Another article on the Umbelliferae in meadow stands (Klapp and Wagener **9**), not part of the series on " Wiesen und Wiesenpflanzen in Mitteldeutschland," discusses their nitrogen and ash content.

The third article of the series on Central German meadows deals with the local conditions and plant stands of 417 Thuringian meadows (Klapp and Stählin **13**). Of 463 species, 233 have been arranged in tables to show their occurrence, their quantity and their frequency at different altitudes, under different moisture conditions and in saline soil. Of the principal forage plants, nine grasses and four legumes, of the other families 12 species are distinguished by unusually stable occurrence in more than two-thirds of the meadows studied. It is possible that in sowing down

grassland full advantage is not taken of the obviously great adaptability of these species, as the seed generally employed consists largely of other or more limited groups of forms. At an altitude of more than 500 metres a series of important forage plants has already disappeared from natural meadows, but only partly on account of climatic conditions. The plants characteristic of hill grassland are not montane plants alone, but to a considerable extent indicators of poor land or raw humus or are woodland relics. Nor does the grading of localities according to moisture conditions reveal the existence of many plants which can be regarded as reliable indicators of definite degree of moisture, for here, as with altitude, convergence with or the substitution of other factors obscure results. The study of localities having soil with a heavy sodium chloride content led to no appreciably fresh conclusions regarding the more well-known halophytes ; the frequency of hygrophilous meadow plants in saline localities is, however, surprising. A species can only be expected to have definite value as an indicator when not only the presence of the species, but also the whole ecology and sociology of each individual case are taken into consideration.

In the fourth article of this series the distribution and value as indicators of species and stands under varying pH conditions are discussed (Klapp, Stählin and Wacker **14**). The authors summarize the results of several years' study of 400 localities. Values for pH of 3.4 to 8.5, sometimes distinctly correlated to altitude, climate, and nutrient content of soil, were determined. Two hundred plant species are tabulated in five pH classes, their general occurrence, relative frequency, and quantities being indicated. Grouping in accordance with their value as indicators is in general agreement with the findings of previous authors. The most important meadow plants have as a rule no great value as indicators. Associations give more exact indication of soil reaction than do individual species. Abundant water supply diminishes the effects of extreme reaction, but lack of water accentuates them. As manuring becomes more comprehensive and ample it has an increasingly annihilating effect upon the influence of reaction. The effects of soil reaction are seen to their full extent only under extreme conditions. In the case of slightly sour and nearly neutral soils the other local characters important for plant growth must be simultaneously studied if the relations between soil reaction, composition and yield capacity of the plant stand are to be recognized.

6. Associations and Other Bodies Connected with Forage Crops and Grassland Farming.

The Landesbauernschaft (formerly Hauptlandwirtschaftskammer) contains a Grassland Association, which has undertaken the care of grassland and field fodder crops, the improvement of methods of hay harvesting and silage, etc. There is also a Lucerne Seed Production Association.

The Thuringian Ministry of Economics is concerned with the general care and in particular with the improvement of marshlands and mountain pasture. There are six centres of the Land Drainage and Irrigation Works for this purpose. These stations are staffed by trained improvement experts, who supervise the drainage, irrigation and cultivation work.

Finally, manurial trials on meadows and pastures are carried out or supported by the Fertilizer Syndicates, particularly the Nitrogen Syndicate and the Potash Syndicate respectively, and their Agricultural Advisory Stations in Weimar.

7. BIBLIOGRAPHY.

The second reference in each case indicates an abstract of the article in question.

1. DEFFNER, C. Der Anbau der Esparsette im Lande Thüringen. Beiträge zur Kenntnis seiner Grundlagen, seines Rückganges und seiner natürlichen und wirtschaftlichen Grenzen. [Sainfoin cultivation in Thuringia. Contributions to the knowledge of its principles, its falling-off, and its natural and economic limits.] *Arch. Pflanzenbau* **3.** 595-646. 1930.
(Abstract available from the Bureau.)
2. IFFLAND, T. Beiträge zur Kenntnis einiger Luzerne-Herkünfte, mit besonderer Berücksichtigung des Samenertrages. [Contributions to the knowledge of some lucernes of different origins, with special reference to their seed yield.] *Pflanzenbau.* **7.** 193-217. 1931.
Herb. Abst. **1.** 20. 1931.
3. KLAPP, E. Thüringische Rhönhuten. Ein Beitrag zur Kenntnis des Graslandes und der Meliorationswirkung im Mittelgebirge. [Thuringian Rhön pastures. A contribution to the knowledge of the grassland and the results of improvement in the Mittelgebirge.] *Arch. Pflanzenbau.* **2.** 704-86. 1929.
Biol. Abst. **5.** Entry 5285. 1931.
4. ———— Studien über Zusammenhänge von Bodenreaktion, Verbreitung der Wiesenpflanzen, Wiesentypen und Wiesenerträgen. [A study of the relations between soil reaction, distribution of meadow plants, meadow types and meadow yield.] *Landw. Jahrb.* **71.** 807-35. 1930.
(Abstract available from the Bureau.)
5. ———— Wiesen und Wiesenpflanzen in Mitteldeutschland. I. Die Trockenwiesen der Aufrechten Trespe (*Bromus erectus* L.). [Meadows and meadow plants in Central Germany. I. The *Bromus erectus* dry meadows.] *Landw. Jahrb.* **74.** 807-27. 1931.
Herb. Abst. **2.** 26-7. 1932.
6. ———— and SCHUBART, E. Ueber Thüringer Luzerne. [On Thuringian lucerne.] *Pflanzenbau.* **7.** 353-65. 1931.
Herb. Abst. **1.** 90-1. 1931.
7. ———— Einiges über Wüchsigkeit und Bewurzelung der geprüften Luzerne-Herkünfte in Jena-Zwätzen. [Some observations on the growing capacity and root system of the lucerne varieties tested at Zwätzen, Jena.] *Mitt. dtsch. LandwGes.* **47.** 208-9. 1932.
Herb. Abst. **2.** 102. 1932.
8. ———— Ueber das Eggen, Ritzen (Verwunden), Walzen und Nachsäen auf Wiesen. [On the harrowing, scarifying, rolling and supplementary sowing of meadows.] *Forts. Landw.* **7.** 361-6, 387-91. 1932.
Herb. Abst. **2.** 229. 1932.
9. ———— and WAGENER, H. Umbelliferen im Wiesenbestande, ihr Stickstoff- und Aschengehalt. [Umbelliferae in the meadow stand, their nitrogen and ash content.] *Arch. Pflanzenbau.* **8.** 755-81. 1932.
Herb. Abst. **2.** 124-5. 1932.
10. ———— Erfahrungen über Luzernesamenbau. [Experiences in lucerne seed growing.] *Mitt. dtsch. LandwGes.* **48.** 181-3. 1933.
Herb. Abst. **3.** 83. 1933.
11. ———— Ertrags- und Eiweissleistung der Luzerne bei verschiedener Schnitthäufigkeit. [Yield and protein content of lucerne under varied frequency of reaping.] *Mitt. dtsch. LandwGes.* **48.** 413-5. 1933.
Herb. Abst. **3.** 262. 1933.

12. KLAPP, E. Die Eiweissleistung der Luzerne. (Grundlagen, Erhaltung und Förderung in ackerbaulicher und züchterischer Betrachtung.) [Protein yield of lucerne. (Establishment, maintenance and furtherance considered from the agricultural and breeding points of view.)] *Mitt. dtsch. LandwGes.* **48**. 999-1001. 1933.
Herb. Abst. **4**. 79-80. 1934.

13. ———— and STAEHLIN, A. Wiesen und Wiesenpflanzen in Mitteldeutschland. III. Häufigkeit, Standorte und Zeigerwert der Arten in Wiesen verschiedener Höhenlage, Feuchtigkeit und Versalzung. [Meadows and meadow plants in Central Germany. III. Frequency, localities and value as indicators of species in meadow of varying altitude and varying moisture and salt conditions.] *Arch. Pflanzenbau.* **10**. 422-52. 1933.
Herb. Abst. **3**. 231. 1933.

14. ———— STAEHLIN, A., and WACKER, F. W. Wiesen und Wiesenpflanzen in Mitteldeutschland. IV. Verteilung und Zeigerwert der Arten und Bestände in Wiesen verschiedener Bodenreaktion. [Meadows and meadow plants in Central Germany. IV. Distribution and value as indicators of species and stands in meadows of different soil reaction.] *Arch. Pflanzenbau.* **10**. 533-57. 1934.
Herb. Abst. **4**. 91. 1934.

15. ———— Bedeutung und Einbürgerung der Luzerne auf ungünstigen Böden. [Importance and establishment of lucerne in unfavourable soils.] *Mitt. dtsch. LandwGes.* **49**. 72-4. 1934.
Herb. Abst. **4** 130. 1934.

16. KLINKOWSKI, M. Lucerne: its ecological position and distribution in the world. Bull. No. 12. Imperial Bureau of Plant Genetics: Herbage Plants, Aberystwyth. 1933. pp. 65.
Nature. **133**. 643. 1934.

17. LEHMANN, H. Luzerneschädlinge. 1. Rüsselkäfer: Phytonomus variabilis Herbst, Sitona lineata L. and Apion pisi F. [Lucerne pests. 1. Weevils: *Phytonomus variabilis* Herbst, *Sitona lineata* L. and *Apion pisi* F.] *Z. PflKrankh.* **43**. 625-38. 1933.
Herb. Abst. **4**. 133. 1934.

18. PAULSSEN. Die klimatischen Grundlagen des Luzerne- und Rotkleesamenbaues in Thüringen. [The climatic basis of lucerne and red clover seed production in Thuringia.] *Pflanzenbau.* **7**. 122-6. 1930.
Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants, Aberystwyth. p. 15. 1931.

19. SCHUBART, E. Beobachtungen an Luzernewurzeln verschiedener Herkünfte. [Observations on the roots of lucerne of different origins.] *Pflanzenbau.* **8**. 137-41. 1931.
Herb. Abst. **2**. 101-2. 1932.

20. ———— Wechselbeziehungen zwischen Ertragsleistung und morphologischen Merkmalen verschiedener Luzerne-Herkünfte unter besonderer Berücksichtigung des Samenertrages. [The mutual relations of productivity and morphological characters in lucerne from different sources, with special reference to seed yield.] *Z. Züchtg. A.* **18**. 322-40. 1933.
Herb. Abst. **3**. 196-7. 1933.

21. ———— Reinsaat oder Deckfrucht bei Luzerne? [Pure sowings or nurse crops for lucerne?] *Dtsch. Landw. Pr.* 1933. No. 16.
Herb. Abst. **3**. 262-3. 1933.

22. STAEHLIN, A. Untersuchungen an Luzerneproben Thüringer Herkunft. [Examination of lucerne samples of Thuringian origin.] *Pflanzenbau.* **6**. 276-81. 1930.
Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants, Aberystwyth. p. 16. 1931.

23. ———————— WAGENER, H., and KLAPP, E. Wiesen und Wiesenpflanzen in Mitteldeutschland. II. Grundlagen, Bedeutung und Bekämpfung der Wiesenverunkrautung mit Doldengewächsen (Umbelliferen). [Meadows and meadow plants in Central Germany. II. The presence of Umbelliferae in meadows; principles, importance and control.] *Landw. Jahrb.* **77**. 621-88. 1933. *Herb. Abst.* **3**. 171. 1933.

24. WHYTE, R. O. The international test of types of lucerne. 1. Organization, procedure, and discussion of technique. *Herb. Rev.* **1**. 125-31. 1933.

25. WILMANNS, W., GAERTNER, R., and KLAPP, E. Die Thüringische Landwirtschaft [Agriculture in Thuringia.] Jena, 1933. pp. 280.

GRASSLAND AND FORAGE CROPS IN CZECHOSLOVAKIA.

1. Natural and soil characters.
   Climate, soils.
2. Natural agricultural regions and production districts.
3. Distribution of research on grassland and fodder crops.
4. Published results of research.
   Bohemia. Forage crops. Meadows and pastures.
   Moravia. Forage crop research at Brno. Herbage plants at Rožnov.
   Slovakia and Sub-Carpathian Ruthenia. Pastures of the Polonina.
5. Bibliography.

1. Natural and Soil Characters.

Climate.

Czechoslovakia is the first of the three countries being studied in which the continental climate has an important influence, especially in its eastern part. The climate, however, is rather variable; in some periods it shows a tendency towards the maritime climate, in others towards the continental. The temperature is fairly uniform, the difference between the hottest and coldest month in the lowlands being greater in the east (23°C.). than in the west (21°C.).

The disadvantage of a low average annual rainfall (about 700 mm.) is counterbalanced by a favourable distribution, two-thirds of the precipitation falling in spring and summer. The driest parts of the country have a rainfall of only 480 mm. per annum, while the rainfall in Sub-Carpathian Ruthenia is about 1,500 mm. The barometric minima are in a west to east progression; therefore the east winds bring dry clear weather, warm in summer and cold in winter, while the west winds bring humid, maritime weather. The geographical latitude has practically no influence on the climatic conditions in the various parts of Czechoslovakia. On the other hand elevation plays a large part in the climate, especially as regards precipitation.

The soil type is mainly dependent on the climate and it is therefore possible to observe a regularity in the distribution of soil types in vertical zones. In the lowlands where the rainfall is slight, there are black soils (Chernozem) and with increasing elevation they become more and more podsolized, thus giving place to brown soils and typical podsols. The difference in elevation in various parts of Czechoslovakia may be considerable (from under 200 m. up to 2,500 m.) and sudden, so that the soil conditions show considerable changes even on a small area. Besides the climatic factor the petrographical character of the geological substratum has a great influence on the development of certain soil types. This is especially noticeable on limy or marl layers, where under special conditions humus carbonate soils develop.

Soils.

Dr. V. Novák (*Ann. Czech. Acad. Agric.* 1. 67-75. 1926) recognizes and maps the following climazonal types of soil which coincide fairly well with the natural production districts to be mentioned later.

1. Soils of the podsol type, with two sub-divisions.

(a) Central European brown soils which prevail in the semi-humid parts of the country up to 500 m. above sea level. The original growth on these soils was deciduous woods and the present area coincides roughly with the cereal production districts. All kinds of cereals are cultivated on these soils, wheat and barley at the lower levels and rye and oats at the higher.

Map No. 6. Czechoslovakia. Rainfall [from Kamenicky, K. *Rec. Inst. Rech. Agron. Rep. Tchec.* 110. 1933.]
[Blank=under 600 mm. ; thin dotting=600-900 .mm. ; thick dotting=900-1200 m.m ; black=1200-1600 mm.]

(b) Typical podsols or grey soils which extend to higher levels (over 500 m.). Originally they were covered with Coniferous woods ; they at present comprise the potato-cereal and meadow-forage districts. The chief crops cultivated are potatoes, rye and oats with forage crops (chiefly white and red clover) for fodder and seed. These soils sometimes reach elevations of over 700 m. where meadows and pastures, if not woods, occur. At the highest levels woods prevail and raw humus or peat is formed on the strongly podsolized soils. Most of the Czechoslovakian soils belong to the podsol type.

2. Black soils (Chernozem) are found chiefly in the lowland areas with low rainfall where originally they were grass steppes on loess. Most of the sugar beet is cultivated on these soils with in addition wheat, barley and lucerne.

3. Humus carbonate soils (Rendzinas) occur on the limy and marl substrata at lower elevations, chiefly in the sugar beet area.

4. Soils on the alluvial deposits in the river valleys mostly in the sugar beet districts.

5. Skeletal soils on the ridges of high mountains where there are only woods.

6. Alkaline, saline soils in the poorly drained lowlands upon which after improvement sugar beet and the other crops of the sugar beet area such as barley, wheat, lucerne, etc. are grown.

2. Natural Agricultural Regions and Production Districts.

According to the orographical, geological, pedological, climatical conditions and the actual distribution of crops, Novák distinguishes 45 natural regions in Czechoslovakia. Where cultivation of a certain crop predominates several of these regions may be grouped into one production district. Novák distinguishes four such districts (*Knik. stat. vest.* Sv. 6. Prague, 1925). (See map No. 7. from Novák.)

A. The sugar beet district is not continuous, having parts in Bohemia, Moravia and Slovakia. Its area amounts to 2,566,800 ha., i.e., 18 per cent of the total cultivated area. The zone is characterized by intensive cultivation ; 83.7 per cent is arable land, meadows comprise 7.8 per cent and pastures only 6 per cent. 45.3 per cent of the arable land is devoted to intensive crops in the following percentages : wheat, 13.2 ; barley, 17.2 ; maize, 3.4 ; sugar beet, 11.6.

On the remaining area more extensive crops are grown in the following percentages : rye, 11.7 ; potatoes, 8.1 ; oats, 6.5 ; and forage crops (lucerne, clovers, etc.)=19.6. The high percentage of forage crops on this arable land is made necessary on account of the small area of meadows and pastures, the intensive dairying and the need of a large amount of farmyard manure for beet cultivation. The high yields obtained indicate the fertility of the soil.

B. The cereal producing district is the largest, covering 5,051,405 ha. or 36 per cent of the total area. The percentages under different types of cultivation are : arable, 46.8 ; meadows, 9.6 ; pastures, 7.7 ; woodland, 28.8. In the animal industry only the raising of young stock is practised. Only 28.3 per cent of the arable land is cultivated with intensive crops in the following percentages : wheat, 12.5 ; barley, 10.5 ; maize, 3.5 ; sugar beet, 1.8. The remaining area is used mainly for rye and oats and the yields in this district are lower than those in the first mentioned.

C. The cereal potato district is the smallest, covering 2,503,735 ha. or 17.3 per cent of the total area. In this district 58.4 per cent comprises agricultural land and 38.3 per cent of the total is arable. Meadows and pastures together comprise one-fifth of the total. The relation between arable land and grassland is 2 to 1. Rye and oats are cultivated on 40.2 per cent of the arable area, potatoes are widely grown as the conditions in this district are most favourable for their development. Where there are distilleries or starch works the fattening of cattle and swine is the most important aspect of the animal industry.

Map No. 7. Czechoslovakia. Agricultural regions and production districts [from Novák].
[Blank=sugar beet district; thin dotting=cereal district; crosses=cereal-potato district; thick dotting=meadow-forage district.]

D. The forage district comprises 27.9 per cent of the total area or 3,915,478 ha.; only 50.7 per cent of the total area is agricultural, being divided in the following percentages: woods, 45.2; meadows, 12.5; pastures, 12.4 of the total area. Intensive crops are grown on 14.9 per cent of the arable land. Extensive crops (with the exception of forage crops on arable land) are cultivated and nearly half of the arable area in the following percentages: oats, 21.2; potàtoes, 14.5; rye, 12.7. Forage crops cover 20.8 per cent of the arable land. Fallowing (9.9 per cent of the arable land) is still employed in this district, especially in Slovakia and Sub-Carpathian Ruthenia. The yields are much lower than in the sugar beet districts for example.

3. Distribution of Research on Grassland and Fodder Crops.

The complete organization of agricultural research in the Czechoslovakian Republic is set out in a Report of the Institutes of Agricultural Research (**52**). As far as this article is concerned it is necessary to mention only a few of the many stations which have been organized, although it will be understood that branch stations are situated in various parts of the different provinces. The chief centre of plant industry research in Bohemia is the State Research Institute of Plant Production in Prague-Dejvice, with its numerous sub-divisions, of which the most important from a grassland and fodder crop aspect are the Institute for Meadows and Pastures (Director, Prof. K. Kavina, Specialist, Dr. A. Klečka) and the Institute for Biology (Director, Dr. J. Stadník, Specialist, Ing. E. Kunz). In the former Institute the main concern is the botanical composition of pastures and its change or possible improvement by fertilizing and manuring and proper cultivation. In the second Institute work is done with the introduction of new ensilage and fodder crops, e.g., *Lupinus*, *Phalaris arundinacea*, *Beckmannia eruciformis*, Sudan grass, millets, etc. The diseases and pests of herbage plants are studied at the Institute for Plant Pathology (Chief, Dr. Fr. Straňak). One of the numerous State Branch Stations in Bohemia under the supervision of the Ministry of Agriculture is that in Tábor, where the breeding of grasses is practised and where the variety " Tábor perennial ryegrass " originated.

The seed testing of herbage plants is done in the Seed Testing Station in Praha (Prague) (Director, E. Vítek). The seed control in Czechoslovakia is of interest. The firms dealing with seed are allowed to sell both for home and foreign use only certified officially controlled seed of clovers and lucerne. The certified seed must be free of dodder and show a high degree of purity and germination. All exported seed has to be officially tested, and this testing is carried out in official stations at Praha, Brno, Bratislava and Košice. This method has proved very successful and the quality of seed in Czechoslovakia is steadily rising. As a result of these regulations the price of clover and lucerne seed is quoted on the produce exchanges.

In Moravia the chief stations of interest to forage crop investigators are the Moravian Institute of Agricultural Research in Brno, and the Institutes of the College of Agriculture and Forestry in the same city. The former is under the supervision of the Moravia-Silesia Provincial Department, and has several subdivisions of which the following may be mentioned as being of interest to the grassland investigator: Seed Testing Subdivision (Chief, Prof. Fr. Chmelař), Plant Breeding Subdivision (Chief, Dr. Kočnar), and the subdivisions for Biochemistry and Plant Pathology. In the Seed Testing Section new crops for Czechoslovakia are systematically tested. All important forage crops are grown either in pure culture or in mixtures (maslin) and their seed production is tested. The laboratory work is especially concerned with varietal germinability, Prof. Chmelař being president of the Commission for the Testing of Varietal Germinability in the International Seed Testing Association. In addition photoperiodism, vegetative rhythmus, physiology and ecology of herbage

plants are studied. On the experiment field of the Seed Testing Station a living collection of about 700-800 varieties of herbage plants is maintained.

In the section for Plant Breeding the local lucerne and the well-known Bohemian red and white clover are improved. The Seed Testing Station works in close co-operation with the Institute of Plant Production and Plant Breeding (Chief, Prof. Dr. Fr. Chmelař) of the College of Agriculture, especially on the Experiment Farm at Žabčice in southern Moravia. This farm is very interesting to the herbage plant worker, because forage is grown there under extremely dry conditions and yet even in the driest year there is ample fodder. This result is obtained by growing a large number of different winter, spring and summer maslins both for drying and ensilage. This farm has also 7 ha. under grass seed production. The seed cultures are in a very good state, which indicates that for growing high class grass seed, especially as regards health of the seed, the best results may be obtained in comparatively dry regions.

The Moravian Institute has a branch station at Rožnov devoted especially to grass and forage crop cultivation (Chief, Dr. L. Brada). At Rožnov local strains of grasses are improved and their seed propagated and distributed among the farmers who are in close co-operation with the Station. The activities of this Station are increasing rapidly, as may be seen from the growing number of co-operating seed producers (in 1930 there were 228, and in 1933, 334). In addition, seeds mixtures for short duration and permanent meadows and pastures are tested.

In Moravia there are two smaller State Experiment Stations concerned to some extent with forage crops ; at Domaninek, in the region which produces the Bohemian clover seed (600 m. above sea level), and at Opava, where numerous forage crops are being tested.

For agricultural research in Slovakia and Sub-Carpathian Ruthenia the State Central Experiment Stations at Bratislava and Košice have been organized, and experiments are carried out with herbage plants for lowland and mountain areas. The Branch Station at Nižní Verecky is primarily concerned with pasturage and the cultivation of meadows in the vicinity of the Station and also in the mountains at a height of 900-1,500 m. above sea level (the Polonina, to which reference will be made in a later section). Here the station livestock graze during the summer and farmers' stock are admitted on a payment of a small fee. At Kernice there is a station for the cultivation of grass and for the renewal of swards.

4. Published Results of Research.

It will be convenient to discuss the literature from the Czechoslovak research workers, of which only the most recent has been selected, from the geographical aspect, proceeding from west to east, from the country of Bohemia, where intensive arable cultivation makes forage crops of importance, through Moravia and Slovakia to Sub-Carpathian Ruthenia, in which direction the pastures assume increasing importance.

In this way the work of the State Research Institute of Plant Production in Prague-Dejvice will be considered first ; then the work in the two separate Institutes in Brno, proceeding to the special forage crop station in Rožnov, and so eastwards to consider ecological studies in the Central Carpathians and the research of Ing. M. Maloch (Košice) on the pastures of the Polonina.

Bohemia.

The type of problems under investigation in the Biology Section of the State Research Institute of Plant Introduction (Chief, Dr. J. Stádník ; specialist, Ing. E. Kunz), and in the Meadows and Pastures Section (Chief, Prof. K. Kavina ; special-

ist, Dr. A. Klečka) is indicated by a review of some of the literature published by these two sections in recent years. The Biology Section carries out most of the work on forage crops, while Dr. Klečka is primarily concerned with grassland improvement.

Forage Crops.

Details and a map of the distribution of lucerne are given by Klinkowski (**41**). Kunz (**42**) has published a preliminary report of variety trials, in which Italian, Hungarian and indigenous varieties were tested for yield and persistence. Results obtained at three different centres showed little difference between the types as regards yield of green or dry matter over a period of five years. It was considered remarkable that the Italian variety should have yielded as much as the others; its yield was higher than the Hungarian and indigenous strains in the first years, indicating its particular value for short duration leys. The Hungarian lucerne did not show any special characteristics of value. In the last winters, the Italian was more winterkilled and therefore it is concluded that an extension of the seed production of indigenous types is advisable.

A preliminary report regarding red clover is given by the same author (Kunz, loc. cit.). In several places a study has been and is being made of about 100 regional varieties of the indigenous red clover, i.e. varieties which have been cultivated for generations in certain *communes* and among certain farmers by reproduction of the same seed. It is considered that by the exclusion of inferior varieties and the dissemination of good varieties, a considerable and relatively rapid improvement among red clovers may be achieved. These best indigenous strains are not surpassed by the best improved foreign strains such as Tystofte and Øtofte, or by seven clovers of Swiss origin which were tested.

A report by Nebovidsky and Horel (**51**) on the soybean is concerned with this legume only from the industrial point of view. Like maize (Stádník **25**), it can be cultivated for seed only under the conditions of Slovakia and Sub-Carpathian Ruthenia. Maize for grain covers 160,000 hectares per annum, while maize for forage and ensilage covers only 22,000 hectares.

A more recent paper (Kunz **43**) describes trials of sweet sorghums, Sudan grass and proso millet as forage plants. All these crops are of some importance only in special cases where maize does not succeed.

The preparation and dissemination of inoculum for treatment of legumes by the Biochemistry Section, and the attempt of outside interests to make financial gain from sale of inoculum for a wide range of plants other than legumes, is described by Hampl (**24**).

Meadows and Pastures.

An indication of the scope of the Meadows and Pastures Section of the Institute of Plant Production is given by reference to the publications of Klečka and others. Klečka's papers consider questions such as sour meadows (**27**), manuring of grassland (**31**), botanical analysis of grassland (**29**), and of hay (**26**), estimation of meadow yield (**32**), management of meadows and pastures in the light of plant sociology (**35**), value of a cover crop in sowing grass seeds mixtures (**33**), and a consideration of manure weeds and the cause of their spread (**38**).

Klečka and Kunz (**36**) have published work on the compiling of suitable clover-grass mixtures, and Klečka and Fabian on the changeability of meadow and pasture stands (**34**), the improvement of quality of hay and fodder from pastures (**39**) and the nitrogenous fertilizing of legumes (**37**).

Klečka has also made ecological studies of stands of *Nardus stricta* in the Bohemian Forest, on the borders of Bavaria. The first of the two articles published

(**28**) deals with the extension of *Nardus* stands in some of these mountainous districts. The occurrence and development of the *Nardus* is attributed largely to clearing of the forest. It is not until about 20 years after clearing that isolated tufts of *Nardus* appear, but their rapid spread produces a close sward within another ten years. The second article (**30**) contains a number of analyses of *Nardus* stands, the determination of frequency being made by a scale of 5 degrees (from very rare to very frequent). Forty analyses are tabulated in which *Nardus stricta* is present up to 95 per cent. The grass is of considerable economic importance in the district; its development can be checked only by shade or by top-dressing with stable manure.

MORAVIA.

The Moravian forage crop literature emanates from the Moravian Institute of Agricultural Research and the Institute of Plant Industry and Breeding in the College of Agriculture at Brno, and the special pasture and forage station at Rožnov. The scope of the research on forage crops in Brno includes variety and cultivation trials of legumes and grasses, tests of seed production technique, seed testing and other laboratory problems, as indicated in the literature reviewed below.

Forage Crop Research at Brno.

Legumes. Chmelař and Mikolášek (**9**) have enumerated the various characteristics of lucerne cultivation throughout Czechoslovakia and summarized the points at which they consider improvement of cultural technique may be made. The same authors deal with red clover in a similar manner (**8**), with development and yield characters of some new bred strains of red clover of various nationality, according to trials during the years 1923-29 (**6**), and with the result of a test of growing red clover and lucerne in rows (**7**). In earlier publications Mikolášek (**48**) and Chmelař and Mikolášek (**6**) points out that the local strains of red clover are best suited to Czechoslovakian conditions, and that the best local varieties produce nearly the same amount of bulk as foreign improved strains. Other studies on legumes reported include the elaboration of a laboratory method for distinguishing single and double cut red clover after growing under long-day conditions by Chmelař and Mostovoj (**18**), and seed testing studies on hard seeds of red clover and lucerne (Chmelař **5**) and on leguminous seeds resistant to swelling (Chmelař and Mikolášek **14**).

Other legumes of partial forage interest which have been studied include soybean (Chmelař **11** and **12**), field peas (Chmelař and Šimon **19**, **21** and **22**), and field beans (Chmelař and Šimon **20**).

Gramineae. Reports of extensive experiments with grasses have been published up to this time, e.g., variety and other trials with *Alopecurus pratensis* (Chmelař and Mikolášek **10**), Sudan grass and sorghums as fodder plants (Chmelař and Šimon **13**), and with maize (and sunflower) as ensilage (Chmelař, Šimon and Mikolášek **15**). Nádvornik (**49**) has studied the weight of seed of forage Gramineae in its relation to germination and development of the seedling.

Other Fodders. Finally, reports have appeared of variety trials of various root crops as fodder (Šimon **54**, Chmelař and Šimon, **16** and **17**).

Seed production. A considerable amount of work has been done at Brno and Zabčice, and the results have been discussed in a separate publication recently (Mikolášek **49**).

This study is a summary of twelve years' experience gained in trials conducted by the Seed Testing Station of the Institute for Agricultural Research, Brno, in the south and west of Moravia. A complete description of the method of growing cultivated grasses for seed is given and a number of improvements are noted. Thus in preparing

the soil for sowing a plank drag gave good service. Different ways of machine and hand sowing are reported. Very good results were given by a special method of sowing in rows between the wider rows of the cover crop, which is an improvement on the Danish sowing method. When sowing without a cover crop white mustard (*Sinapis alba*), 10-15 kg. per hectare, was sown in the same row together with the grass seed. It helps the grass seedlings to break the soil crust, marks the row for cultivation, shelters the seedlings against too intensive insolation in drought periods and, after the mustard has been cut at the commencement of flowering, it brings them some moisture. Besides the spring sowing, summer sowing after the harvest of some early crop in June and July has been found successful, because at that time the highest amount of precipitation occurs in Moravia. Sowing grass in different parts of Moravia was tried. For cultivation of grasses for seed special cultivators are recommended. The influence of late cutting in autumn, fertilizing, liquid manuring and deep cultivation on the seed yield in the next year was tested. The best way of harvesting proved to be the "Brno method" of putting up the cut stalks in special bundles, described in detail. For seed cleaning a special cleaning machine built by D. Drexler, Kojetín, is recommended. The process of cleaning is described, and the yields obtainable in four of the places in the west of Moravia where experiments were conducted are presented in a table.

Herbage plants at Rožnov.

About 100 miles east of Brno, but still in Moravia, is the Research Station for Fodder Crop and Grass Production at Rožnov. This is the first station, when studying Czechoslovakia from west to east, in which the research programme is concerned more with the plant constituents of meadows and pastures than with the forage crops and plants of temporary leys cultivated under the more intensive agriculture of the west of Czechoslovakia. The following extracts from the report of the Director, Dr. L. Brada, for 1931, will indicate the general scope of the Station (**4**).

The work of the Station increased considerably in the year in question, not only as regards research activities but in particular in practical and advisory work. The number of producers of grass seeds and the extent of such cultivation had shown a great increase in the previous year, necessitating the installation of more seed cleaning machinery. Rožnov is an important centre for grass seed production, and the members of the local associations have their seed collected and cleaned at the Rožnov Research Station.

The following items indicate the research in progress during the year reviewed by the Report.

1. Testing suitable mixtures for meadows and pastures,
2. testing of short-period mixtures for one to two-year leys, mixtures being 80 per cent red clover and 20 per cent a particular grass species,
3. fertilization of grass seed production areas, species being *Festuca rubra genuina*, *F. pratensis* and *Lolium perenne*,
4. increasing doses of N, P and K on *Lolium perenne* for seed,
5. autumn sowing of grass seed areas,
6. utilization of nitrogen by individual grass cultures,
7. influence of increasing doses of nitrogen on seed yield of various grasses,
8. fertilizing meadows at different periods in the same year,
9. normal doses of nitrogen on meadows,
10. increasing doses of nitrogen on meadows,
11. increasing doses of phosphorus on meadows,
12. increasing doses of potash on meadows,

13. fertilizing of meadows in autumn and in spring,
14. the use of superphosphate and basic slag,
15. varying times of harvesting,
16. mechanical treatment,
17. additional sowings,
18. winter and spring mixtures, with objects of obtaining three fodder crops in one year.

Among the species which are subjected to selection with a view to improvement and the production of elite strains are *Alopecurus pratensis*, various species of *Poa*, *Festuca rubra*, *F. pratensis*, *Phleum pratense*, *Dactylis glomerata*, *Lolium perenne*, *Agrostis alba* and *Cynosurus cristatus*. Elite strains of the following species have been propagated at Rožnov and elsewhere: *Festuca pratensis*, *F. rubra*, *Poa fertilis*, *P. nemoralis*, *Avena flavescens*, and *Dactylis glomerata*.

The practical activities of the Station include the propagation of grass seed among the local farmers, with the object of producing sufficient seed for home requirements, and restricting the import from abroad of such species as *Lolium perenne*, *L. italicum*, *Festuca pratensis*, *Dactylis glomerata*, *Agrostis alba* and *Cynosurus cristatus*.

The literature published by the staff of the Rožnov Station includes a contribution to the estimation of *Poa fertilis* (Brada **1**), a study of the value of *Cynosurus cristatus* for meadow and pasture mixtures (Demela and Brada **23**), a report of trials with thirteen grass species in connection with the framing of ideal clover-grass mixtures for permanent leys (Brada and Demela **3**). A small popular paper by Brada (**2**) deals with the cultivation and local importance of lucerne.

Slovakia and Sub-Carpathian Ruthenia.

The main interest of Eastern Czechoslovakia as far as herbage literature is concerned, lies in the mountain pastures of the Carpathians, including the so-called "Polonina" pastures of Sub-Carpathian Ruthenia, the most easterly portion of the Czechoslovak Republic. Studies on these pastures have dealt with the plant associations from a purely ecological point of view, or, in the case of the work of Ing. M. Maloch, with the agronomical improvement of the Polonina.

Rechinger and Scheffer, German ecologists, have reported upon a study of the north-western part of the Central Carpathian Range, more especially the Liptau Alps in western Slovakia (**53**). The summits of these mountains are from 1900 to 2000 m., and are generally gently rounded with steep approaching slopes. Woodland, scrub and meadow formations are described, and the last-named is divided into the hydrophilous and mesophilous groups. In the mesophilous meadows are further distinguished the valley grassland (750—800 m.), subalpine meadows (1400-1500 m.), alpine pastures (1500-2000 m.). The botanical associations of each are noted, together with the dominance or recession respectively of each species, this being determined from a study (in each case) of 13 different sample areas of approximately 1 sq. m.

The chief subject of study in Eastern Czechoslovakia is, however, the *Nardus* swards which are characteristic of the high elevation grasslands, under severe climatic and poor soil conditions.

Klika (**40**) has made a sociological study of the *Nardus* stands of the Great and Little Fatra Mountains, using Braun-Blanquet methods. These swards are governed by the anthropogenous factor and soil conditions, and arise after the destruction of the brushwood and montane mixed forest in the subalpine zone and the forest (mainly beech) in the montane zone. In the latter, especially where the subsoil is other than granite, these Nardeta occur as a degraded stage of a previous meadow associa-

tion, "*Anthoxantheto-Agrostidetum fatrense*," and form meadows which are regularly mown, or pastures in the higher localities. They are associated with soils which are very to slightly sour; these original forest soils are calcium-deficient through leaching, and are deep and more or less red-brown in colour. The *Nardus* pastures are so characteristic of this soil that they may be mapped out by means of a geological map. The Nardion alliance is represented in the subalpine zone by the *Nardus stricta-Phleum alpinum* association; in the lower parts of the montane zone the *Nardus* stands comprise the sub-association *Nardetum strictae agrostidetosum.*

All the extensive meadowland of the montane zone of the Great Fatra Mountains is of this nature. The meadows are mown annually and produce a hay resembling in its chemical composition that of *Anthoxanthum-Agrostis* meadows. The meadows and pastures composed of *Nardus stricta* and *Phleum alpinum* are changed by intensive grazing into stands of low nutritive value in summer owing to the hardness of the *Nardus* leaves. Under present conditions it is difficult to improve the botanical composition of these swards, since lack of water makes employment of animal manures impossible. Some improvement might possibly be achieved by using artificial fertilizers.

Pastures of the Polonina.

The alpine pastures of Sub-Carpathian Russia (Ruthenia) are situated above the forest line, some 1200 m. above sea level, the total area of 107,000 acres affording pasturage for approximately 100,000 animals from the end of May until mid-October. These pastures, of which 82 per cent belong to the State and are rented at a moderate rate, are of great importance to the many small farmers of the country, since climate and the nature of the land make cattle raising more profitable than arable farming.

The chief work in the improvement of the quality of a part of these lands, the Borzava pastures, has been done by M. Maloch. Several publications (**44**, **45**, **46** and **47**) have given the results of experiments, chiefly concerned with the eradication of *Nardus stricta*. The Borzava pastures consist of 10,300 acres, at elevations up to 1679 m.; the soil is mainly sandstone, the climate severe, and *Nardus stricta* is the prevailing type of vegetation. Rainfall is heavy, but there is no excess of moisture owing to permeability of the soil and adequate run-off. The lands are seriously overgrazed.

The various methods by which improvement is effected include mechanical treatment with various cutters, irrigation and manurial treatment, the fertilizers used being farmyard and liquid manure, $CaCO_3$ and kainite. The Kernice Seed Testing Station is studying the question of the most suitable species for resowing these reclaimed lands, and is reproducing the necessary seed.

5. BIBLIOGRAPHY.

The second reference in each case is that of an abstract.
Articles are in Czech unless a French or German title is given in addition to the English.

1. BRADA, L. [Contribution to an estimation of *Poa fertilis.*] *Česk. Zem.* 1928. pp. 10. [Translation available.]
2. ———— [Lucerne, its cultivation and importance.] *Včela Moravská.* **64**. No. 4. 1931. pp. 8. [Full translation available.]
3. ———— and DEMELA, J. [Contribution to estimating the value of thirteen grass species in clover-grass mixtures as a basis for the composition of ideal mixtures for permanent meadows.] *Rec. Inst. Rech. Agron. Rép. Tchéc.* **68**. 1931. pp. 224. [German summary, 216-20.]
4. ———— [Report on the work of the Rožnov Research Station for Forage Crops and Grass Production for the year 1931.] Prague, 1932. pp. 7. [Translation available.]
5. CHMELAŘ, F. [Course of germination of hard seed of red clover and lucerne in the laboratory and in the field.] *Bull. Czech. Acad. Agric.* **4**. No. 2. [English summary.] 1928.
   Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants. p. 12. Aberystwyth, 1931.
6. ———— and MIKOLÁŠEK, F. [Growth and yield qualities in some new bred strains of red clover: trials 1923-1929.] *Bull. Czech. Acad. Agric.* **6**. 3-10. [German summary, 10.] 1930. [Abstract available.]
7. ———— [A trial of growing red clover and lucerne in rows.] *Bull. Czech. Acad. Agric.* **6**. 173-8. [German summary 177-8.] 1930. *Herb. Abst.* **1**. 21-2. 1931.
8. ———— [Our present methods of cultivating red clover and a criticism thereof.] *Bull. Czech. Acad. Agric.* **6**. 268-74. [German summary 273-4.] 1930. [Translation available.]
9. ———— [Methods of cultivating lucerne in Czechoslovakia and possibilities of improvement.] *Bull. Czech. Acad. Agric.* **6**. 469-73. [German summary 472-3.] 1930. [Translation available.]
10. ———— [Valuable characters of bred strains of meadow foxtail.] *Bull. Czech. Acad. Agric.* **7**. 267-74. [German summary, p. 274.] 1931. *Herb. Abst.* **1**. 56-7. 1931.
11. ———— [Development and ripening of the soybean, 1921-1930.] *Bull. Czech. Acad. Agric.* **7**. 520-5. [German summary, pp. 524-5.] 1931. [Abstract available.]
12. ———— [Experience of growing soybeans in Czechoslovakia. (Replies to a questionnaire.)] *Bull. Czech. Acad. Agric.* **7**. 684-7. [German summary, p. 687.] 1931. *Herb. Abst.* **1**. 93-4. 1931.
13. ———— and ŠIMON, J. [The development of Sudan grass and of some Sorghum species sown as forage plants.] *Bull. Czech. Acad. Agric.* **7**. 688-95. [German summary, p. 695.] 1931. *Herb. Abst.* **1**. 88. 1931.

14. CHMELAŘ, F., and MIKOLÁŠEK, F. [The growing ability and yields of plants from some leguminous seeds resistant to swelling.] *Bull. Czech. Acad. Agric.* **7**. 695-704. [English summary, 703-4.] 1931.
Herb. Abst. **1**. 89-90. 1931.

15. ———— ŠIMON, J. and MIKOLÁŠEK, F. [Variety trials with maize and sunflower, cultivated for ensilage in Moravia and Silesia in 1929 and 1930.] *Sbor. vyzk. úst. zeměd. RCS.* **88**. 1932. pp. 22.

16. ———— [Trials of bred strains of fodder carrots, 1931.] *Bull. Czech. Acad. Agric.* **8**. 201-7. [German summary, 206-7.] 1932.

17. ———— [Yields obtained from bred strains of turnip in trials conducted in 1931.] *Bull. Czech. Acad. Agric.* **8**. 207-12. [German summary, 211-2.] 1932.

18. ———— and MOSTOVOJ, K. [A laboratory method for distinguishing single and double cut red clover after growth under lengthened day.] *Bull. Czech. Acad. Agric.* **8**. 734-41. [English summary, 741.] 1932.
Herb. Abst. **3**. 43-4. 1933.

19. ———— and ŠIMON, J. [New bred strains of peas and lentils and their useful properties. I. Morphology and vegetation rhythm.] *Bull. Czech. Acad. Agric.* **9**. 109-17. [German summary, 116-7.] 1933.
Herb. Abst. **4**. 140. 1934.

20. ————[The results of trials of bred strains of field beans, 1931-32.] *Bull. Czech. Acad. Agric.* **9**. 127-34. [German summary, 133-4.] 1933.
Herb. Abst. **3**. 119. 1933.

21. ———— [New bred strains of *Pisum* and *Lens esculenta* and their agricultural properties. II. Yield capacity and quality of seed.] *Bull. Czech. Acad. Agric.* **9**. 265-70. [German summary, 270.] 1933.
Herb. Abst. **4**. 140. 1934.

22. ———— [New improved varieties of field peas and their useful qualities.] *Bull. Czech. Acad. Agric.* **10**. 129-34. [German summary, 134.] 1934.
Herb. Abst. **4**. 140. 1934.

23. DEMELA, J., and BRADA, L. [Should *Cynosurus cristatus* be included in seeds mixtures for meadows and pastures?] *Rec. Inst. Rech. Agron. Rép. Tchéc.* **59**. 1930. pp. 84. [German summary, 78-81.]

24. HAMPL, B. Matiéres servant à l'inoculation des légumineuses en Tchécoslovaquie. [Inoculants for legumes in Czechoslovakia.] [Paper presented to] 15th Inter. Cong. Agric. Prague. 1931. pp. 2.

25. STÁDNÍK, J. La culture du maïs en Tchécoslovaquie. [The cultivation of maize in Czechoslovakia.] 1930. pp. 7.

26. KLEČKA, A. [On the botanical analysis of hay.] *Zem. Arch.* **17**. 401-7. 1926.
[Full translation available.]

27. ———— [Sour meadows.] Prague, 1926. pp. 29.

28. ———— [A study of the *Nardus stricta* stands of the Bohemian forest pastures.] *Bull. Czech. Acad. Agric.* **5**. No. 38. 1929.

29. ———— [Botanical analysis of grassland and the importance of experiments.] *Zem. Arch.* **21**. 239-63. 1930.
[Abstract in French.] *Zem. Arch.* **22**. I.-III. 1931.

30. ———— [A study of the *Nardus stricta* populations of the Sumava pastures.] *Ann. Czech. Acad. Agric.* **5**. 101-38. [French summary, 136-8.] 1930.
[Abstract available.]

31. ———— Essais sur le fumage des prairies. [Manurial trials on grassland.] [Paper presented to] 15th Inter. Cong. Agric. Prague, 1931. pp. 2.

32. KLEČKA, A. [The evaluation of meadow yield and requisite considerations.] *Zem. Arch.* **22**. 117-20. 1931.
33. ———— [Importance of a cover crop in sowing grass mixtures.] *Hospodáre Českosl.* **62**. 1932. pp. 11.
[Full translation available.]
34. ———— and FABIAN, J. [The essential facts in regard to the changeableness of meadow and pasture stands.] *Zem. Arch.* **23**. 1932. pp. 16.
35. ———— [Management of meadows and pastures in the light of plant sociology.] *Zem. Arch.* 23. 1932. pp. 14.
36. ———— and KUNZ, E. [The basis of combining the seeds of clover and grass.] *Zem. Arch.* **23**. 121-7. 1932.
Herb. Rev. **1**. 110-1. 1933.
37. ———— and FABIAN, J. [On the nitrogenous fertilizing of legumes.] *Hospodársky obzor.* **6**. 1933. pp. 12.
[Full translation available.]
38. ———— [Liquid manure weeds and the cause of their spreading.] *Zem. Arch.* **24**. 118-27. 1933.
Herb. Abst. **4**. 112-3. 1934.
39. ———— and FABIAN, J. [Proposition for the improvement of the quality of hay and herbage.] *Zem. Arch.* **24**. 308-14. 1933.
Herb. Abst. **4**. 121. 1934.
40. KLIKA, J. [*Nardus stricta* pastures in the Great and the Little Fatra Mountains.] *Bull. Czech. Acad. Agric.* **10**. 61-5. [German summary, 63-5.] 1934.
Herb. Abst. **4**. 92-3. 1934.
41. KLINKOWSKI, M. Lucerne : its ecological position and distribution in the world. Bull. No. 12. Imperial Bureau of Plant Genetics : Herbage Plants, Aberystwyth. 1933. pp. 65.
Nature. **133**. 643. 1934.
42. KUNZ, E. Expériments d'observation avec les papillonacés. Rapport préliminaire. [Variety trials of legumes. Preliminary report.] [Paper presented to] 15th Inter. Cong. Agric. Prague. 1931. pp. 4.
43. ———— [Trials of sweet sorghums, Sudan grass and proso millet as forage plants.] *Zem. Arch.* **24**. 130-8. 1933.
Herb. Abst. **4**. 126. 1934.
44. MALOCH, M. [Problems of the Polonina.] *Zem. Arch.* **20**. 449-80. 1929.
45. ———— [Destruction of *Nardus stricta* by irrigation.] *Zem. Arch.* **21**. 445-50. 1930.
[Full translation available.]
46 ———— [The Borzava mountain pastures in the Russian Carpathians.] *Rec. Inst. Rech. Agron. Rép. Tchéc.* **67**. 1931. pp. 200. [German summary, 193-8.]
Herb. Abst. **2**. 88-9. 1932.
47. ———— Kali als Mittel zur Bekämpfung des Borstengrases (*Nardus stricta* L.). [Potash as a means of controlling *Nardus stricta* L.] *Ernähr. Pfl.* **27**. 54-6. 1931.
Herb. Abst. **1**. 19. 1931.
[Full translation available.]
48. MIKOLÁŠEK. Fr. [Importance of the origin of red clover seed and trials of clovers of different origin, 1913-1915 and 1924-1926.] *Zem. Arch.* **18**. 19-46. [German summary.] 1927.
[French summary in] *Zem. Arch.* **19**. II-III. 1928.
49. ———— [Experience in grass seed production and cleaning.] *Cas. Spis. Minist. Zem. Prague*. No. **76**. 124. [German summary.] 1934.
Herb. Abst. **4**. No. 3. 1934.

50. NÁDVORNÍK, J. [The weight of the seeds of forage grasses and its relation to germination and to the development of the seedling.] *Bull. Ecole Sup. Agron. Brno.* No. 9. 1927. pp. 65. [French summary, 60-5.]
Biol. Abst. **3**. Entry 837. 1929.

51. NEBOVIDSKY, J., and HOREL, J. Cultivation expérimentale de soyas en Slovaquie et résultats des examens, tenant compte de leur utilisation industrielle. [Experimental growing of soybeans in Slovakia and the results of analysis, with special reference to their industrial utility.] [Paper presented to] 15th Inter. Cong. Agric., Prague. 1931. pp. 3.

52. PRAGUE, State Institutes of Agricultural Research. Agricultural research in the Czechoslovak Republic. *Rpts. Inst. Agric. Res. Czech. Rep.* **48c**. 1931. pp. 40.

53. RECHINGER, K. H., and SCHEFFER, J. Zur Kenntnis der Flora und Vegetation der Liptauer Alpen (Zentralkarpathen). [The flora and vegetation of the Liptau Alps (Central Carpathians).] *Rep. Spec. Nov. Regn. Veg.* **31**. 284-312 and 337-57. 1933.
Herb. Abst. **3**. 71. 1933.

54. ŠIMON, J. [Trials of fodder carrot varieties and parsnips for yield and quality, 1931 and 1932.] *Česk. Zem.* **15**. No. 14. 1933. pp. 8.

GRASSLAND AND FORAGE CROPS IN HUNGARY.

1. Physical factors in relation to agriculture. Topography, soils, climate.
2. Relative position in Hungarian agriculture.
3. Distribution of forage crops.
   Lucerne—*Trifolium* spp.,—*Anthyllis*—*Onobrychis*—*Vicia*—*Pisum*—Miscellaneous fodders
4. Plant Breeding.
   General.
   Plant Research Stations.
   Private selection stations.
   Royal Hungarian Seed Control Station.
5. Published work on forage crops and meadow plants.
   Lucerne.
   Other Legumes.
   Grasses.
6. Seed Production and Trade.
7. Bibliography.

1. Physical Factors in Relation to Agriculture.

Topography.

From the point of view of topography, post-war Hungary may be divided into three principal regions, namely, the Hungarian lowlands of south-eastern Hungary (Alföld), the north Hungarian hill country (Upper-Hungary) and the Transdanubian section of western Hungary (Transdanubia).

Soils

(a) The great plain of the Alföld has an average elevation above sea-level of 90-120 metres. The soil of this plain is more or less uniform, but the principal soil types are so located that each constitutes a continuous area. Sand is the predominant soil in the north-east of the lowlands, with dune areas here and there. To the south, the sand is replaced by chernozem, a black loam with a reputation of inexhaustible fertility, which covers the greater part of the Alföld. According to the Map of Soil Regions of Hungary [by Peter Treitz (**1**)] six soil types occur in the Alföld :—chernozem, sandy chernozem, dune sand, black clay, alkali-clay and alkali-sand, upon the following respective subsoils : loess, marl, sand, marl, alkaline marl and alkaline sand.

The Alföld was in earlier times subject to flooding by the rivers, especially the Tisza and its tributaries, but since their regulation and the draining of the stagnant waters, five million cadastral yokes (cad. yoke = 1.421 acres) have been made available for agriculture. The trouble is now on the increase again, owing to excessive de-afforestation of the upper reaches by the Rumanians.

(b) In Transdanubia is a section higher than the Alföld in elevation, but the soil is mostly podsolized limy loam and the subsoil most frequently gravel. A considerable part of these " little Hungarian Lowlands " is occupied by marsh suitable only for third-class grass.

(c) The remainder of Transdanubia is hilly and contains limy-loam or loess soils of varying fertility which are generally suitable for the production of all field crops.

(d) The soils of Upper Hungary are rarely sandy, frequently loam and clay.

Climate.

The climate of Hungary, more particularly that of the Alföld, is characterized by frequent occurrence of extreme conditions. The average annual precipitation in the lowlands is 500-600 mm., but certain parts in certain years may show minima and maxima of 300 mm. and 700 mm. respectively. In Transdanubia,

Map No. 8. Hungary. Rainfall [from Beke]·
[Blank=under 550 mm. ; thin dotting=550-650 mm. ; thick dotting=650-750 mm. ; black=750-850 mm.]

with a more uniform distribution of rainfall and an average annual precipitation of over 600 mm., conditions are relatively more favourable for crop production. The wheat yields in Transdanubia do not show such wide fluctuations as in the Alföld, where very high yields and low yields frequently occur. It is characteristic of the climate of the Alföld that during the past century there were 22 years of excessive drought and only six years of excessive moisture.

2. Relative Position in Hungarian Agriculture.

As a result of the Treaty of Trianon, Hungary lost two-thirds of her former territory. Her population was reduced from 21,000,000 to 8,600,000 ; 56 per cent of her arable land, 69 per cent of her pastures, 85 per cent of her forests, 74 per cent of her meadows, and 74 per cent of her gardens passed into the hands of Czechoslovakia, Rumania and Jugoslavia.

Eighty-one per cent of the total measured area of present-day Hungary is under cultivation, the types of cultivation being as follows : arable land = 59.5 per cent, meadows and pastures 18 per cent, gardens and vineyards = 3.5 per cent. Fifty-six per cent of the population is engaged in agriculture. The following are more detailed figures of the various crops and cultures, in percentages : Wheat=28, rye=12.1, barley=7.7, oats=5.0, maize=19.6, potatoes=4.9, sugar beet=1.2, temporary

meadows and fodder crops (clover, lucerne, fodder beet, beans and green fodder) =14.0, other crops and fallow land 7.5. The distribution of the different crops is given in map form by Beke (**1**).

The main trend in the future will be towards a reduction in the area under cereals in favour of legumes, commercial plants (tobacco, hemp, rape for oil, sunflower, etc.), industrial plants and forage crops. The necessity of increasing the value of the exports and readjusting agriculture on a strictly intensive basis, in place of the present extensive system adopted on many farms, requires the continuation of this trend. In recent times there has been a development in grassland farming, supported by an attempt to improve 650,000 ha. of gramineous fodder crops and 1,700,000 ha. of meadows and pastures (out of the total area of 5,600,000 ha. in Hungary). This development must necessarily be supported by the selection of improved varieties of meadow and pasture grasses, which will be done at Magyar-Ovár and elsewhere. It is natural that grassland agriculture does not acquire the position under Hungarian climatic conditions than it assumes in the northern and western more humid lands.

Information used in sections 1 and 2 has been derived from Morgan (**28**) and Kallbrunner (**24**).

3. Distribution of Forage Crops.

The information used in this section is extracted from Villax (**35**) and other sources.

Lucerne.

Hungarian lucerne, which consists mainly of *sativa* forms, is characterized by longevity, its power to recover rapidly after cutting, giving four to five cuts per annum, and by great winterhardiness and capacity to tolerate long periods of drought. It is the most important forage crop in Hungary, having achieved this position since the Great War. Before that time, red clover held first place, but with the loss of numerous districts of higher rainfall, this crop has now fallen to second place.

Fig. No. 5 in Klinkowski (**25**) indicates the general distribution of the crop in Hungary; the best region for hay production is the higher rainfall area of Transdanubia, while the seed production is largely confined to the more arid Alföld (see Map No. 9. from Beke **1**).

The chief breeding of Hungarian lucerne is carried on by Ing. Rudolf Fleischmann in his breeding grounds at Kompolt, in the most northerly part of the seed production area indicated in Map No. 9. Further reference will be made to the Kompolt station later. Fleischmann has shown that Hungarian lucerne offers excellent material for selection work, as it is possible to recognize the following types among the initial breeding material:—many-leaved and broad-leaved individuals of various growth forms, early flowering individuals with high seed production, late flowering less fertile forms with better leaf development, together with hardy, long-lived, drought resistant and alkali-resistant types. A list of Fleischmann's papers is given in the bibliography.

Other legumes.

Red clover (*Trifolium pratense*) is grown chiefly in the moister districts of Transdanubia and North Hungary. The average annual rainfall in the red clover districts is not actually very much greater than that of the Alföld, so that the Hungarian red clover type is still regarded as having a comparatively high capacity to resist drought. It is also resistant to cold and mildew attack.

Other clover species cultivated are *Trifolium incarnatum* and *T. repens*; *T.*

incarnatum is very important as a spring fodder in western Hungary. The areas in which seed of these plants is produced are indicated Map No. 9.

The cultivation of *Anthyllis vulneraria* is confined to the damp sandy districts of Hungary, where it replaces lucerne and red clover. The area under this crop decreased considerably during and after the Great War, but a gradual recovery is now in progress.

Onobrychis sativa occurs on the shallow soils where lucerne cannot be grown successfully. The annual and biennial types of sweet clover (*Melilotus* spp.) are used as green manure or as fodder for animals unaccustomed to high-class forage, this being the case more particularly in districts covered with drift sand which are unsuitable for growing more valuable fodder plants.

The various species of vetch and field pea together cover a greater acreage than either lucerne or red clover. The most common species of vetch is *Vicia sativa*, which is sown mixed with oats ; there is now a tendency to discard this species in favour of the autumn species of vetch, which affords a more certain and more abundant—and therefore cheaper—yield of fodder. *Vicia villosa* is one of the most reliable autumn plants for poor sandy soils, as it yields a satisfactory crop and also improves the fertility of these poor, infertile soils. The area under this species is increasing yearly, and a considerable export trade is carried on, principally with North America. Owing to its high capacity to resist drought, the cultivation of *Vicia villosa* had a tendency to extend into the regions with better soil conditions, in particular the lowland region of the Alföld. At the present time, its place in these better regions is being taken by *Vicia pannonica*, Hungarian vetch ; as this type requires good soil conditions, however, it will not compete with hairy vetch in the infertile sandy lands.

Hungarian vetch was introduced into cultivation by the Royal Hungarian Plant Production Experiment Station, Magyar-Ovár, and it has had a very good reception among the farmers on better class soils. Seeds are being produced on a considerable scale. It yields more seed than *V. villosa* and, being more frost resistant than that plant, can be sown even later in the autumn. This quality is of great advantage where there is a tendency to drought, as protracted dry periods prevent the sowing of seeds in September. *Vicia pannonica* is very palatable and is being recommended more particularly to dairy farmers.

Vicia sativa hiberna (autumn vetch) is also grown on a small scale, mixed with some cereal ; its lower powers of frost resistance made possible its cultivation only in regions with a milder climate and in rich soils subject to intensive cultivation.

Pisum sativum is sown with oats or barley, although not so frequently as the vetch-oats mixture already mentioned. In the sandy soil regions unsuitable for the more sensitive vetch, there has been a continuous increase in the area under the sand pea (*Pisum arvense aestivum*), which is much stronger and more drought-resistant than the common vetch. It is sown mixed with oats. As the plants produce abundant seeds, it is considered that its cultivation for fodder in sandy regions would be profitable. The autumn pea (*Pisum arvense hibernum*) is also grown, but to a lesser extent, being confined more or less to the better class soils.

Maize is cultivated either as a primary crop or as a secondary product to be sown after other crops have been harvested. It is considered to be one of the most important fodder plants grown in Hungary. Other fodders are sunflower, millet, foxtail millet, Sudan grass and rye ; the last mentioned crop when cut in the spring in the green state furnishes the first green fodder of the year.

4. Plant Breeding.

General.

Considerable attention is given to the breeding of herbage and fodder plants, as the continental climate of Hungary does not favour the ordinary commercial

varieties originating from countries with less extreme and more humid climates. Selection of suitable strains is carried on at various Government Stations, in particular Magyar-Ovár, and on a number of the large private estates in various parts of the country. The selection of grasses is naturally of more importance to the western part of the country, lucerne being the chief fodder crop of the Alföld, except in certain areas where alkali-resistant grasses such as *Atropis limosa* are of importance. Among the species selected are *Lolium perenne, L. italicum, Arrhenatherum elatius, Dactylis glomerata, Phleum pratense, Alopecurus pratensis, Festuca pratensis, F. rubra, Bromus inermis, Avena flavescens, Poa pratensis, P. trivialis* and *Agrostis stolonifera.* The main object in selection is the production of superior hay types with longevity, resistance to frost and disease and other characters influencing palatability and good hay and seed yield (Grabner **20**, **21** and Pap **29**).

The problem of suitable forage crops for the more arid parts of the Alföld is also receiving attention at Kompolt, Szeged and private estates. The selection of drought resistant varieties and the introduction of new species are receiving attention. Plants which show promise are hybrid lucernes, *Vicia villosa, V. pannonica, Melilotus albus* and Sudan grass (Fleischmann **11**).

The types of lucerne and red clover produced under the continental conditions of Hungary are suitable for countries in more northern latitudes, such as Germany, Sweden, etc. An efficient seed control system elaborated by the Royal Hungarian Seed Control Station at Budapest plays an important part in maintaining the good reputation of Hungarian seed for export purposes.

Plant Research Stations.

Royal Hungarian Plant Breeding Institute, Magyar-Ovár.

This Institute, established in the year 1909, serves as the advisory organ of the Ministry of Agriculture in questions relating to plant improvement and seed production (in respect of varieties and races). It directs and controls the technical activities of Hungarian plant breeders, giving advice free of charge and examining breeding material on the spot. Research work on plant breeding questions is also carried on in the nursery, experimental gardens (20 hectares in area) and the laboratories in Magyar-Ovár. It also directs experiments in various parts of the country for the purpose of testing improved varieties. A register of varieties is kept which officially certifies right of ownership of varieties belonging to Hungarian plant breeders.

Royal Hungarian Estate, Kompolt.

The establishment at Kompolt, under the directorship of Ing. Rudolf Fleischmann, was originally a branch station of the Seed Growing and Seed Trading Co., Ltd., but in view of the very valuable work in progress at Kompolt, state assistance has now been given for its furtherance.

The following notes taken during a visit by the author to Kompolt on July 1st, 1933, will indicate the range of problems as far as forage crops are concerned. Fleischmann is also concerned with the improvement of various other crops ; selected strains (indicated by " F " for Fleischmann) of the following agricultural plants are on the market :

Wheat (for alkaline soils)	Hemp.
Rye	*Cicer arietinum.*
Maize	Lucerne.
Flax	*Vicia villosa.*

His forage crop work was noted as follows :

(1) A comparison of New Zealand white clover, *Trifolium repens*, seed received

from E. Bruce Levy, Palmerston North, New Zealand, with local strains. The New Zealand was proving definitely superior to local Hungarian or Slovakian.

(2) A pasture form of *Medicago sativa* with underground running stems was being studied.

(3) Tests were being made with numerous strains of lucerne from the Soviet Union against Hungarian as check.

(4) Fleischmann is collaborating with Prof. L. R. Waldron of North Dakota, in a study of yield and flower colour in lucerne, using various types including North Dakota Common, Grimm, Ladak, Hardistan, etc.

(5) In the vicinity of Kompolt a large field had been planted out with single plants of lucerne, 15 women planting 1 yoke = approx. 1 acre, 4500 plants per day. The field was to be used as a basis for selection of new strains of Hungarian lucerne. It has since been learnt that the seed yield from this field in autumn of 1933, i.e., in the first harvest year, was 250 kg. per hectare (=200 lb. per acre) which is considered to be a very satisfactory result.

(6) Also in the vicinity was seen a plot of *Lotus corniculatus* which was to be taken for seed in 1934.

(7) Selection of *Vicia villosa* var. *glabrescens* was in progress.

(8) Attempts were being made to cross *Aegilops* and rye (unsuccessful).

(9) Comparisons were being made between the common local sainfoin and *Onobrychis viciaefolia* var. *persica* Sirj. The latter has a much taller habit, gives three cuts instead of one and is winter-resistant.

(10) Fleischmann was attempting to show that the leguminous species *Coronilla varia* is not poisonous, as it has been stated to be. A lamb had been fed on 2 kg. of the plants per day for three weeks.

(11) Records were being kept of dew precipitation and of the effect of frosts on soil movements. In the latter case, records were taken at 7 a.m. and 2 p.m. Where there was the greatest range between the two readings, then plants such as wheat tended to receive damage to their root system.

(12) An attempt was made to select a form of maize with more upright leaves so that any moisture precipitated could run down the leaves and the stems to the roots, instead of to the tips of the leaves, where it would drop on the soil and evaporate without being available to the plant.

Items 11 and 12 give an indication of the steppe character of the locality, at the north-eastern limits of the Alföld, where drought and severe winter conditions are common features.

Royal Hungarian Institute for Lowland Agriculture. Szeged.

This Institute has charge of the conduct and development of the agriculture of the Great Hungarian Plain (Alföld), through the four experiment stations which it contains (**30**). These stations are as follows:

(1) *Royal Hungarian Experiment Station for Cultivation of Flax, Hemp and Oil Plants.*

The activities of this station extend over all Hungary, covering the cultivation and manufacture of flax, hemp and other fibre plants, and the cultivation and subsequent extraction of oil from oil plants (oil-flax, sunflower, oil-rape, etc.), delivering the crude material to the oil factory. The task of the station is thus to develop experimental, investigational and other researches in agricultural, chemico-technological, and mechanical-technological problems.

(2) *Royal Hungarian Experiment Station for Plant Industry.*

The Station is concerned with experiments and general research on plants, and

also with the supplying of opinions or advice on any matter in general and special cultivation of agricultural plants, other than those which are the concern of special stations. Those questions which are of special importance in the improvement of management in the Alföld receive preference ; these include management of sandy and alkaline lands, meadows and pastures, artificial cultivation of forage, choice of wheat, potato and maize varieties, proper cultivation and fertilizing of the soil, correct use of farmyard manure, accurate preparation of seed for sowing, suitable cultivation and protection of plants against injury, etc.

The scope of this station is confined to the Great Hungarian Lowland (Alföld).

(3) *Royal Hungarian Agrochemical and Soil Research Station.*

The task of this station is to study all facts relating to soil science, especially the relative fertility and fertilizer requirements of the soils with, in addition, the examination of questions of soil improvement, plant nutrition, etc. The most important questions as far as the Alföld is concerned are :

(a) Fertilization, amelioration and cultivation of the soil according to the climate and other circumstances in the Alföld. Study of fertilizer requirements and the effect of different fertilizers.

(b) Amelioration of alkaline soils by various methods and using various materials. Utilization of periodically flooded and drained lands. Amelioration of alkaline meadows and pastures, and of sandy soils and marshlands. Cartography of the land in the Alföld.

(4) *Royal Hungarian Agricultural Experiment Station for Chemistry and Paprika.*

All analyses of commercial products which may be desired by authorities, merchants, peasants, manufacturers and private persons are carried out in these laboratories.

A special task of the station is the registering of the quality of the paprika (red pepper), and to place on the sack the state sign of quality and the lead seal. Assistance of a general kind is given to producers to the counties (Comitats) of Csanád-Arad-Torontál, Csongrád and South Pest and to the free towns of Szeged and Hódmezövásárhely.

Private Selection Stations.

As already stated, a considerable amount of work is done on selection of improved strains of grasses and legumes by private stations, operated on the estates of the great landowners or of seed trading companies. For example, on the estate of Prince Eszterhàza at Eszterhazy, Karl Dworak, formerly assistant to Fleischmann, is also breeding lucerne. Kompolt has been breeding lucerne since 1918, Eszterhazy since 1920. Besides these two stations for lucerne breeding, another exists in the west of Hungary, near Sopron, on the Austrian frontier (Transdanubia), i.e. in the region where the crop is grown for fodder, not in the actual seed production district.

A list of the private breeders in Hungary is given by Grabner (**21**).

Royal Hungarian Seed Control Station.

This Station has charge of the seed testing work in Hungary. It was under the direction of the eminent Hungarian botanist, Dr. Árpád von Degen, up to the time of his death in March, 1934. The station has done excellent work in introducing principles of clean, high-quality seed into Hungarian agriculture ; in particular, its strict rules regarding contamination of red clover and alfalfa seeds with *Cuscuta*, and its experiments in the development of special seed cleaning machinery have been of great importance to the seed trade. (Lengyel **27**.)

According to the Danish seed journal, *Dansk Frøavl* (**3**), a new category of lucerne has been introduced by the Station, certified under the " white " seal. This seal is used for seed harvested within the historic territory of Hungary and later transported to Budapest for cleaning and sealing ; such seed is described on the certificate as " Transito lucerne," to distinguish it from seed grown in present-day Hungary.

5. Published Work on Forage Crops and Meadow Plants.

The Hungarian plant breeders and botanists publish the results of their experiments in their own journals, *Köztelek* and *Kisérletügyi Közlemények* (Reports of the Hungarian Agricultural Experiment Stations) or in German and other Continental periodicals. The following sections deal with some articles which have appeared on (a) lucerne, (b) other legumes, (c) grasses.

Lucerne.

Publications on this crop are found under the names of Fleischmann, von Degen, Grabner, Gyárfás, Lengyel and Villax among others.

Von Degen published two papers on Hungarian lucerne which might be noted : one in German (**4**) and another of similar content in English (**5**), The qualities of the Hungarian strains of lucerne are enumerated and the methods adopted by the Seed Control Station to ensure good quality seed are outlined. Owing to the fact that the lucerne seed production area represents only a fraction of the whole agricultural area, itself considerably reduced under the Treaty of Trianon, the export of lucerne seed from Hungary can seldom reach the level of 200 waggon-loads, and the seed will therefore be prevented from playing any important role in international trade.

Grabner has discussed the injuries caused to seed production areas of lucerne and red clover by insect pests (**19**), and has described mechanical and biological methods of control (**22**).

A report of an experiment conducted by the Experiment Station at Magyar-Ovár (Transdanubia) has been given by Gyárfás (**23**). Seed of four different varieties were sown in 1930, namely, Hungarian, Italian as sold in Hungary, Italian from Umbria, and Italian from Emilia. Taking Hungarian as 100, the yields of Italian were 88.1, 74.3, and 75.4, respectively.

Lengyel (**26**) studied the seed of Hungarian lucerne, and found that it was possible to distinguish between seed from the Alföld and Transdanubia on the basis of weed seed content.

Villax has produced a book on the cultivation of lucerne in Hungary (**36**) and two articles which should be mentioned, one on fertilizer trials with lucerne, red clover and sainfoin (*Onobrychis*) (**38**) and the other on the agricultural value of Crescat, sand, Grimm and Franconian lucernes (**39**). The suitability of *M. sativa* and of hybrid lucernes to various soil groups in the country are noted.

Most of the research on Hungarian lucerne has, however, been done by Fleischmann, six of whose papers can be discussed briefly. Three are concerned with the breeding of lucerne. The first article (**7**) deals with the initiation of breeding by artificial self-fertilization and vegetative propagation subsequent to the preliminary separation of forms. For practical purposes, a grouping of the forms according to flowering behaviour proved very important, as a series of other important processes are connected with time of flowering. The article further discusses agents of pollination (chiefly the honey bee) and the correlation between seed yield and green yield. Fleischmann's second breeding article (**8**) gives general observations on the arrangement, form and size of the lucerne leaf and the relation of leaf movements to the control of transpiration, an important factor in Hungarian conditions. Lucerne flower colour is the subject of the third article (**13**). Strains from many parts of the world were analyzed for this character in the Kompolt breeding grounds.

Two other articles by Fleischmann (**10**, **14**) supply data from variety trials of Hungarian versus foreign strains. Finally, a paper on the occurrence and distribution of pure *Medicago sativa* and hybrid lucerne, with particular reference to their respective root systems, should be included (**17**).

Other legumes.

Grabner has published an article on fertilization in red clover (**18**), Villax on root nodule formation in clovers, vetches, peas and lupins (**37**), and Degen and Villax on the agricultural value of Volhynian red clover (**6**). The last named article states that the Volhynian and Hungarian strains are similar in performance, and that no serious results would accrue from an importation of the former in the case of a poor seed year in Hungary.

Fleischmann has published an article on the breeding of *Robinia* (**16**) and another on the breeding of two new forage plants for arid regions, *Vicia villosa* var. *glabrescens*, and *Onobrychis viciaefolia* (**15**).

Grasses.

Relatively few published articles have dealt with grasses. Mention may be made of a series by Surányi on Sudan grass (**32** and **34**), Johnson grass (**31**), and *Beckmannia eruciformis* (**33**) and two by Fleischmann on *Festuca* variety trials and related topics (**12** and **9**).

6. Seed Production and Trade.

From the foregoing passages it will have been seen that the seed production of forage crops is an important factor in the agriculture and that the Government does its utmost to maintain the good name of Hungarian products in other countries. Thus in 1931 Germany imported 90 per cent of her requirements from Hungary, and large quantities of *Vicia* spp., and *Trifolium incarnatum* were exported from

ap No. 9. Hungary. Seed production of legumes [from Beke].

Hungary to U.S.A. The climatic conditions of Hungary during the summer months are of the type which promotes good seed development and ripening and facilitates harvesting of the seed crop in a dry condition. For this reason, seed firms in other countries frequently grow their seed requirements of their own varieties under contract on the seed farms of Hungary.

It is impossible in the scope of this brief review to deal adequately with this aspect of the cultivation of herbage crops in Hungary. Some attention may be devoted to this subject in a future publication. In the meantime further information can be found in the special booklet published in English on " Seed Production and Seed Trade in Hungary " for the 4th International Congress of the Seed Trade, Budapest, 1930 (**2**).

7. BIBLIOGRAPHY.

The second reference in each case is that of an abstract.
A title placed in square brackets and not preceded by a German title indicates that the ticle is in Hungarian.

1. BEKE, L., and others. The best areas of production for the principal agricultural export goods of Hungary. Budapest, 1933. pp. 2. maps 14.
Herb. Abst. **4**. 16. 1934.
2. BUDAPEST, Hungarian Seed Merchants' Association. Seed production and seed trade in Hungary. [Presented to the] 4th Internat. Cong. Seed Trade, Budapest, 1930. pp. 48.
3. DANSK FRØAVL. "Transito-Lucerne." Meddelelse fra den kgl. ungarske Statskontrol i Budapest. ["Transito-Lucerne." Report from the Royal Hungarian Institute for Seed Control, Budapest.] *Dansk Frøavl.* **16**. 51. 1933.
Herb. Abst. **3**. 153. 1933.
4. DEGEN, A. von. Die ungarische Luzerne. [Hungarian lucerne.] *Forts. Landw.* **1**. 17-8. 1926.
5. ———————— Hungarian alfalfa. [Contained in] Seed production and seed trade in Hungary. pp. 10-8. Budapest, 1930. *See* Budapest, Hungarian Seed Merchants' Association.
6. ———————— and VILLAX, Ö. Ueber den Anbauwert des wolhynischen Rotklees. [On the agricultural value of the Volhynian red clover.] *Kisérletügyi Közlemények.* **35**. 5. 1932.
Herb. Abst. **3**. 43. 1933.
7. FLEISCHMANN, R. Beitrag zur Züchtung der ungarischen Luzerne. [Contribution to the breeding of Hungarian lucerne.] *Z. Pflanzenz.* **11**. 211-40. 1926.
Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants. p. 5. Aberystwyth, 1931.
8. ———————— Pflanzenzüchterische Betrachtungen am Luzerneblatt. [Plant breeding observations on the lucerne leaf.] *Pflanzenbau.* **3**. 97-9. 1926.
Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants. p. 5. Aberystwyth, 1931.
9. ———————— Versuchsergebnisse mit Stecklingskultur bei einem sterilen Wiesenschwingel. [The results of an experiment in growing cuttings of a sterile *Festuca pratensis*.] *Forts. Landw.* **2**. 124-6. 1927.
10. ———————— Versuche mit verschiedenen Luzerneherkünften. [Trials with lucernes of different origin.] *Pflanzenbau.* **6**. 18-21. 1929.
Bull. No. 4. Imperial Bureau of Plant Genetics: Herbage Plants. p. 9. Aberystwyth, 1931.
11. ———————— Grundlagen des Futterbaues in Trockengebieten. [The principles of forage crop cultivation in dry districts.] *Wien. Landw. Z.* **80**. No. 3. 1930. [Abstract available.]
12. ———————— Untersuchungen über den Wert von Wiesenschwingelherkünften. [The value of meadow fescues of different origins.] *Wien. landw. Z.* **80**. No. 24. 1930.
[Abstract available.]
13. ———————— [Lucerne flower colour as a distinguishing mark of origin.] *Köztelek.* **41**. 988-9. 1931.
Herb. Abst. **2**. 35. 1932.
14. ———————— Ergebnisse von Luzerneherkunftsversuchen 1927-1931. [Results of lucerne variety trials, 1927-1931.] *Pflanzenbau.* **9**. 13-7. 1932.
Herb. Abst. **2**. 244. 1932.

15. FLEISCHMANN, R. Züchtung von zwei neuen Futterpflanzen für Trockengebiete. [The breeding of two new forage plants for arid regions.] *Züchter.* **4**. 219-25. 1932.
Herb. Abst. **2**. 238-40. 1932.
16. ———————— Beiträge zur Robinienzüchtung. [The breeding of *Robinia*.] *Züchter.* **5**. 85-8. 1933.
[Abstract available.]
17. ———————— [Hungarian lucerne.] *Köztelek.* **43**. 334. 1933.
Herb. Abst. **4**. 62. 1934.
18. GRABNER, E. Die Befrüchtungsverhältnisse bei Rotklee und ihre Beziehungen zur Züchtung dieser Pflanze. [Fertilization conditions in red clover and their relationship to the breeding of this plant.] *Z. Pflanzenz.* **4**. 326-8. 1916.
[Translation available.]
19. ———————— Samenbau des Rotklees und der Luzerne. [Seed production of red clover and of lucerne.] *Köztelek.* 1929. No. 45.
[Abstract available.]
20. ———————— Die ungarische Gräserzüchtung. [Grass breeding in Hungary.] *Z. Pflanzenz.* **15**. 295-8. 1930.
[Abstract available.]
21. ———————— The present position of plant-breeding in Hungary (with special reference to the breeding of fodder plants and to the regulation by law of the trade in improved seeds). [Contained in] Seed production and seed trade in Hungary. pp. 23-31. Budapest, 1930. *See* Budapest, Hungarian Seed Merchants' Association.
22. ———————— [Successful seed production in lucerne and red clover.] *Köztelek.* **43**. 272. 1933.
Herb. Abst. **4**. 39. [For " Brabner " read " Grabner."] 1934.
23. GYÁRFÁS, J. [Trials of Italian and Hungarian lucerne.] *Köztelek.* **43**. 889. 1933.
Herb. Abst. **4**. 62-3. 1934.
24. KALLBRUNNER. Der Pflanzenbau in Ungarn. [Crop growing in Hungary.] *Pflanzenbau.* **7**. 274-6. 1931.
25. KLINKOWSKI, M. Lucerne : its ecological position and distribution in the world. Bull. No. 12. Imperial Bureau of Plant Genetics : Herbage Plants, Aberystwyth. 1933. pp. 65.
Nature. **133**. 643. 1934.
26. LENGYEL, G. [A study of the sources of Hungarian lucerne seed.] *Kisérletügyi Közlemények.* **32**. 555. 1929.
Bull. No. 4. Imperial Bureau of Plant Genetics : Herbage Plants. p. 14. Aberystwyth, 1931.
27. ———————— Seed control in Hungary. [Contained in] Seed production and seed trade in Hungary. pp. 32-40. Budapest, 1930. *See* Budapest, Hungarian Seed Merchants' Association.
28. MORGAN, O. S. Agricultural systems of middle Europe. A symposium. Edited by O. S. Morgan. New York. 1933. pp. 424.
29. PAP, E. Die ungarische Pflanzenzüchtung. [Plant breeding in Hungary.] *Züchter.* **2**. 238-44. 1930.
[Abstract available.]
30. SZEGED, Magyar Királyi Alföldi Mezögazdasági Intézet. [Szeged. Royal Hungarian Institute for Lowland Agriculture.] n.d. pp. 4.
[Translation available.]
31. SURÁNYI, J. [Observations on Johnson grass.] *Mezögazdaság.* **8**. 177. 1931.
Herb. Abst. **2**. 29. 1932.

32. SURÁNYI, J. Kann Sudangras beweidet werden ? [Can Sudan grass be grazed ?] *Deuts. landw. Pr.* **59**. 303. 1932.
Herb. Abst. **2**. 236. 1932.

33. ———— [Fresh data on the agricultural value of *Beckmannia eruciformis*.] *Köztelek*. **48**. 533. [1932.]
Herb. Abst. **2**. 207. [For " Janos " read " Surányi."] 1932.

34. ———— [Recent experience of Sudan grass.] *Mezögazdaság*. **10**. No. 14. 1933.
Herb. Abst. **3**. 108. 1933.

35. VILLAX, Ö. Cultivation of fodder plants in Hungary. [Contained in] Seed production and seed trade in Hungary. pp. 1-9. Budapest, 1930. *See* Budapest, Hungarian Seed Merchants' Association.

36. ———— [The cultivation of lucerne.] Published by the author. Magyaróvár. 1931.
Herb. Abst. **2**. 99. 1932.

37. ———— [Studies of root nodule formation in the principal varieties of clover, vetch and peas and in lupins.] *Kisérletügyi Közlemények*. **35**. 189-97. [English summary, 197.] 1932.
Herb. Abst. **4**. 4. 1934.

38. ———— Gefässdüngungsversuche mit perennierenden Kleearten. [Fertilizer experiments on some perennial leguminous crops.] *Ernähr. Pfl.* **28**. 161-5. 1932.
Herb. Abst. **2**. 143. 1932.

39. ———— [The agricultural value of Crescat, sand, Grimm and Franconian lucerne.] *Köztelek*. **43**. 701. 1933.
Herb. Abst. **4**. 63. 1934.

IMPERIAL AGRICULTURAL BUREAUX.

EXECUTIVE COUNCIL,
2, Queen Anne's Gate Buildings, London, S.W.1.

IMPERIAL BUREAU OF SOIL SCIENCE,
Rothamsted Experimental Station, Harpenden, Herts.

IMPERIAL BUREAU OF ANIMAL NUTRITION,
The Reid Library, Rowett Institute, Bucksburn, Aberdeen.

IMPERIAL BUREAU OF ANIMAL HEALTH,
Veterinary Laboratory, New Haw, Weybridge, Surrey.

IMPERIAL BUREAU OF PLANT GENETICS (FOR CROPS OTHER THAN HERBAGE),
School of Agriculture, Cambridge.

IMPERIAL BUREAU OF PLANT GENETICS (HERBAGE),
Agricultural Buildings, Alexandra Road, Aberystwyth.

IMPERIAL BUREAU OF FRUIT PRODUCTION,
East Malling Research Station, East Malling, Kent.

IMPERIAL BUREAU OF ANIMAL GENETICS,
King's Buildings, University of Edinburgh, Scotland.

IMPERIAL BUREAU OF AGRICULTURAL PARASITOLOGY,
Winches Farm, Hatfield Road, St. Albans, Herts.

IMPERIAL BUREAU OF PLANT GENETICS : HERBAGE PLANTS.

Director	Prof. R. G. STAPLEDON, C.B.E., M.A.
Chief Officer	R. O. WHYTE, Ph.D.
Assistants	Miss G. M. ROSEVEARE (Librarian).
	Miss M. HALL, M.Sc.

IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS.

HERBAGE PUBLICATION SERIES.

Editor: Dr. R. O. Whyte.

CORRESPONDING EDITORS.

Argentina: Dr. William E. Cross, Estación Experimental Agricola, Casilla de Correo 71, Tucuman.

Australia: Dr. B. T. Dickson, Council for Scientific and Industrial Research, Division of Plant Industry, Box 109, P.O., Canberra City, F.C.T.

Austria: Dr. E. K. Feichtinger, Versuchswirtschaft Gross-Enzersdorf, Vienna.

British Colonies and Protectorates: F. A. Stockdale, C.M.G., C.B.E., Agricultural Adviser to the Secretary of State for the Colonies, 2, Richmond Terrace, Whitehall, London.

Canada: Dr. L. E. Kirk, Central Experimental Farm, Ottawa.

Czechoslovakia: Professor F. Chmelař, Seed Testing Station of the Institute of Agricultural Research, Kvetná, 19, Brno.

Denmark: Dr. K. Dorph-Petersen, Statsfrøkontrollen, Thorvaldsensvej 57, Copenhagen V.

Finland: Dr. C. A. G. Charpentier, Pasture Experimental Station, Mouhijärvi, Selkee.
A. Jäntti, 26, Kirkkokatu, Kuopio.

France: Professor A. Chevalier, Muséum National d'Histoire Naturelle, 57, Rue Cuvier, Paris V.

Germany: Professor Dr. E. Klapp, Institut f. Acker- u. Pflanzenbau d. Landw. Hochschule, Hohenheim, Stuttgart, Württemberg, Germany.

Holland: Dr. C. K. Van Daalen, Bilthoven, Holland.
Professor C. Broekema, Instituut voor Plantenveredeling, Wageningen.

Hungary: Saatzuchtdirektor Rudolf Fleischmann, Pflanzenzuchtstation, Kompolt.

India: B. C. Burt, C.I.E., M.B.E., Imperial Council of Agricultural Research, New Delhi.

Irish Free State: M. Caffrey, Plant Breeding Division, Albert Agricultural College, Glasnevin, Dublin.

Italy: Dr. E. Pantanelli, Stazione Agraria Sperimentale, Bari.

Jugoslavia: Professor Dr. Alois Tavčar, Institut für Pflanzenzüchtung der Universität, Zagreb.

New Zealand: E. Bruce Levy, Plant Research Station, Palmerston North.

Norway: Professor M. Ødelien, Norges Landbrukshøiskole, Landbrukshøiskolen i Ås, Norway.

South Africa: Dr. I. B. Pole Evans, Department of Agriculture, Division of Plant Industry, 590, Vermeulen Str., Pretoria.

Sweden: Dr. G. Giöbel, Svenska Betes- och Vallföreningen, Ultuna, Uppsala.

Switzerland: Dr. F. Wahlen, Eidg. landwirtschaftliche Versuchsanstalt, Oerlikon-Zürich.

United States of America: Dr. A. J. Pieters, United States Department of Agriculture, Bureau of Plant Industry, Washington, D.C.
C. R. Enlow, United States Department of Agriculture, Bureau of Plant Industry, Washington, D.C.

U.S.S.R.: Dr. A. I. Belov, Central Plant Breeding Station of the N.I.Kh.I., Tashkent ,P.O., Box 2.
A. Favorov, Ukrainian Institute of Plant Breeding, Odessa, P.O., Box 152.
I. S. Travin, U.S.S.R., Institute for Fodder Research, Lugovaya, Moscow Region.

HERBAGE PUBLICATION SERIES.

Herbage Abstracts } Inclusive annual subscription (1934) .. .. 15s. (Separate numbers .. 5s.)
Herbage Reviews }

Bulletins: See below for prices of separate issues.

Herbage Abstracts, which appears quarterly, deals with literature from all parts of the world on grassland and forage crop research and practice. An effort is made to reduce the interval between the appearance of a paper and of its abstract to a minimum.

Herbage Reviews represents the only Journal published in English which deals exclusively with grassland and forage crops. Contributions and correspondence are welcomed from all investigators on this subject, with the reservation that it is to be understood that no scientific paper representing the results of original (not yet published) research can be considered for publication.

Bulletins of the Herbage Publication Series are issued at irregular intervals as material accumulates on some special subject coming within the terms of reference of this Bureau. Details of issues still available are given below.

Specimen copies of these publications will be sent to any person interested, on request.

Details of Bulletins to date :—

Bull. Nos. 1, 2, 5 and 8. Out of print.

Bull. No. 3. The breeding of herbage plants; Technique adopted at the Welsh Plant Breeding Station. June, 1931. 3s.

Bull. No. 4. Abstract-Review of lucerne literature during the period 1925-30. September, 1931. 2s. 6d.

Bull. No. 6. Research on forage crops in Soviet Central Asia, with special reference to Turkestan lucerne. March, 1932. 1s. 6d.

Bull. No. 7. Further contributions on the technique employed in the breeding of herbage and forage plants. May, 1932. 2s.

Bull. No. 9. Vernalization, or Lyssenko's method for the pre-treatment of seed, by R. O. Whyte and P. S. Hudson. March, 1933. 2s. 6d.

Bull. No. 10. Grazing. Papers read at the meeting of the British Association for the Advancement of Science at Leicester on September 11th, 1933, by P. F. Astill, A. Bridges, W. Davies and M. G. Jones. September, 1933. 1s. 6d.

Bull. No. 11. Technique employed in grassland research in New Zealand. Foreword by A. H. Cockayne, and contributions by E. Bruce Levy, J. W. Hadfield, A. W. Hudson, J. W. Calder, W. A. Jacques, B. W. Doak and N. R. Foy. September, 1933. 3s.

Bull. No. 12. Lucerne: its ecological position and distribution in the world, by M. Klinkowski, [Translator—G. M. Roseveare.] November, 1933. 3s. 6d.

Bull. No. 13. Plant breeding in the Soviet Union. Achievements, organization and future programme of the Institute of Plant Industry. November, 1933. 3s. 6d.

Bull. No. 14. Grassland research in Australia: Future programme and contributions on pasture technique. February, 1934. 3s.

Bull. No. 15. Grassland and forage crops in Thuringia, Czechoslovakia and Hungary, by R. O. Whyte and collaborators. August, 1934. 3s. 6d.

Printed by the
Cambrian News (*Aberystwyth*), *Ltd.*
500/8/34.